Neural and Cognitive Effects of Customized Music Therapy

Tracie Liu

Introduction

Music therapy has a unique connection to the brain. Music, a fundamental aspect of connection and expression, can tap into people's cognitive and emotional systems, activating memory, attention, and motor functions. These effects enable music to support physical and mental well-being in ways other therapies do not. Although music therapy is increasingly used in neurological care for patients with diseases such as Alzheimer's, Parkinson's, and dementia-which involve declines in cognitive capabilities and movement-it remains underutilized in clinical settings. While many experiments have demonstrated its promising results, it is not yet fully integrated into mainstream treatment for neurological disorders. A main cause of this is the lack of clarity and research on how musical elements, like genre, tempo, rhythm, and familiarity, drive cognitive improvements. Therefore, clinicians may struggle to apply music therapy in a structured, evidence-based way within treatment and recovery plans. From this emerges the central question of the paper: How do customizations affect cognitive benefits in patients with neurological disorders? This paper will examine findings from clinical studies and brain imaging research to evaluate how personalization in music therapy shapes therapeutic outcomes.

Clinical Benefits of Music Therapy

Music therapy's true value comes from the many ways it can support a person's well-being. Its measurable effects on cognition, emotion, behavior, and daily function have been shown through numerous studies and experiments with patients with various neurodegenerative diseases. Specifically, it improves the cognitive function and emotional well-being of patients with Alzheimer's and dementia, while enhancing gait and mobility in patients with Parkinson's disease.

Cognitive outcomes in music therapy encompass a wide range of mental domains, primarily memory, language, attention, and orientation. In a study on the effects of music therapy on patients with Alzheimer's disease and dementia, therapy sessions led to an increase in cognitive processes and understanding (Gallego & García, 2017). Using the Mini-Mental State Examination (MMSE), a cognitive screening test consisting of 30 questions, the study assessed Alzheimer's and dementia patients at baseline, after 6 sessions, and after 12 sessions of music therapy. Patients showed approximately a 60% increase in attention, around a 40% increase in memory and orientation, and roughly a 15% increase in language at the end of the study based on the MMSE. The researchers reasoned that this was due to music therapy's ability to stimulate neuronal connectivity, especially because neurodegenerative diseases usually lead to loss in neuron connections. Additionally, music therapy triggers emotional arousal, leading to greater memory retention and increased overall well-being and satisfaction. The study also compared the effects of music therapy on patients with mild and moderate dementia. Both groups experienced roughly a 40% increase in orientation, language, and memory, with the only difference being a slight decrease in language scores for the mild dementia group. However, these improvements were not examined across a long-term timeframe, underscoring the need for further research on the sustained effects of music therapy.

Furthermore, in a recent review on the effect of music on cognitive impairment, many studies noted cognitive improvements in memory and attention as a result of music therapy

applications (Rajakumar & Mohan, 2024). For example, one of the studies that was reviewed pointed out that when patients with schizophrenia performed oddball tasks while listening to Hindustani classical music, there was enhanced attention, arousal, and processing speed (Ahuja et al., 2020). Music may act as an external cue that enhances internal cognitive processing, aiding with attention and memory. Improved cognitive focus can also apply to real-world functions, thereby improving the quality of life for patients with neurological disabilities. In another study, patients with cognitive decline were split into two groups, with one taking computer-assisted training listening to music while the other group had no music (Smith & Wang, 2021). The experimental group with music experienced improved memory and quality of life. Enhancing the effect of computer-assisted training reveals music's ability to allow patients to engage more fully in tasks. Shown through multiple studies, music engages and enhances multiple networks, such as attention, memory, and emotion when paired with structured tasks.

Beyond cognitive changes, music therapy also influences emotional well-being. The study on the cognitive, psychological, and behavioral effects of music therapy on Alzheimer's and dementia measured emotional outcomes using the Neuropsychiatric Inventory and Hospital Anxiety and Depression scale (Gallego & García, 2017). Generally, music therapy led to a decrease in mood disorders and emotional symptoms in both patients with mild and moderate dementia. Additionally, improvements in depression were especially significant in mild dementia, while anxiety and apathy showed greater progress in moderate dementia. Because cognitive function was likely more intact for patients with mild dementia, it is possible music therapy was able to stimulate memories and emotions, alleviating depression. In contrast, researchers hypothesized that in moderate dementia, patients likely have stronger emotional or nervous symptoms, making them more responsive to the calming and engaging effect of music. Especially in Alzheimer's disease, patients may experience agitation or depression stemming from the frustration of a decline in memory and reasoning. Music therapy can slow down this decline and improve patient independence. By demonstrating its positive effects on emotional stability, music therapy establishes its role in contributing to a patient's emotional recovery from neurodegenerative diseases. Such improvements contribute to greater patient well-being, help limit disease progression, and reduce caregiver burden and distress.

Dementia and Alzheimer's disease profoundly impact behavioral symptoms such as agitation, aggression, and hallucinations. These create daily challenges, making basic tasks difficult. Additionally, behavioral challenges and communication problems can lead to a decline in physical and motor capabilities. The study on music therapy for Alzheimer's and dementia used the Neuropsychiatric Inventory to measure how behavioral and psychological symptoms of neurodegenerative diseases change over time with music therapy intervention (Gallego & García, 2017). Improvement was relatively steady throughout the 12 sessions, though they increased in significance in the later sessions. While disinhibition improved for both mild and moderate dementia groups, improvements in delusions, hallucinations, irritability, and agitation were particularly prominent in moderate dementia patients. Researchers hypothesized this was due to higher baseline impairment in moderate dementia, making improvements more measurable and noticeable. Music may be able to provide immediate emotional regulation to patients with greater impairment, resulting in greater improvements in behavioral symptoms. By enhancing the quality of life for patients and reducing emotional and psychological strain for caregivers, music therapy can be a significant tool in helping patients with neurodegenerative diseases reduce behavioral symptoms.

Beyond dementia, music therapy has also been applied to motor and functional outcomes. In a review article on the effects of music therapy in Parkinson's disease, most studies showed positive findings in control and movement (García-Casares, Martín-Colom, & García-Arnés, 2018). Significant improvements were found in proprioception, gait, motor timing, eye movement latency, dysarthria, articulateness, respiratory function, and posture. Specifically, many studies focused on and found positive outcomes in coordination, rigidity, and mobility. However, while most studies showed general improvement, there were a few that resulted in no gait improvement and reduced upper-limb functionality. Ultimately, functional outcomes are complex and vary widely, as they heavily depend on therapy type, task demands, and patient conditions. Different tempos and genres may not suit all patients, and many individual traits may influence patient responsiveness. However, music therapy is a stepping stone and can be integrated into physical rehabilitation.

Although cognitive, emotional, behavioral, and functional outcomes are often measured separately, they are deeply connected and intertwined. Difficulties in one area can worsen the state of other symptoms; however, addressing one area can result in positive improvements in others as well. For example, increased emotional regulation reduces agitation, making daily function and attention easier. Furthermore, reduced anxiety and depression may allow for increased cognitive changes and improvements. By integrating cognitive, emotional, and motor functions, music therapy provides a holistic therapy method that can target multi-domain recovery and rehabilitation.

Music Therapy Modalities

Music therapy exists in many forms, each of which produces different cognitive and emotional benefits. These modalities include Receptive, Interactive, Re-creative, Improvisational, and Compositional Music therapy, as well as Rhythmic Auditory Stimulation. The following section examines each modality individually, supported by specific studies and examples.

Receptive Music Therapy is when a patient listens to a chosen piece of music to evoke emotional or cognitive responses or benefits. Studies show that this form of therapy improves consciousness in coma patients, enhances memory recall in Alzheimer's patients, and improves memory, mood, attention, and executive function in dementia residents (Rajakumar & Mohan, 2024). Receptive Music Therapy activates many damaged areas of the brain, creating neural connections and triggering memories through familiarity and emotional resonance. It enhances cognitive function, improving memory and mood while reducing anxiety and depression among patients. Because it requires little energy and cognitive effort, it is very accessible to people with high cognitive decline or physical limitations. It also requires minimal equipment to deliver and is easily adaptable.

In contrast to Receptive Music Therapy, Interactive Music Therapy encourages active participation and engagement from patients (Tsoi et al., 2018). Interactive Music Therapy generally involves playing instruments, singing, or improvising. It engages motor skills and coordination to achieve improved communication, emotional regulation, and social interaction. The hands-on approach makes it more physically and cognitively demanding than Receptive Music Therapy. Through direct participation, Interactive Music Therapy fosters more self-expression and a greater sense of accomplishment compared to Receptive Music Therapy. Due to its high demand for engagement, it typically works better in higher-functioning patients in

early stages of disease progression. Because it requires more resources, Interactive Music therapy is better suited to structured rehab or group sessions for better cost-efficiency.

When comparing the overall effectiveness of Interactive Music Therapy compared to Receptive Music Therapy, it was found that the group that received Interactive Music Therapy had no significant benefits compared to the Usual Care and Active Controls group (Tsoi et al., 2018). However, patients who received Receptive Music Therapy showed significant reductions in apathy, anxiety symptoms, agitation, and behavioral problems compared to ones with Usual Care. The effect was especially prevalent in the subgroups with moderate to severe dementia. Receptive therapy showed clearer benefits, possibly because it required less effort. In cases of mild to moderate dementia, where patients may not have the mental capacity to engage in physical activities, improvements from receptive therapy are especially notable. Interactive Music Therapy may have shown clearer benefits in earlier stages of dementia, or in different neurological disorders that have less effect on cognitive impairment. Passive listening in Receptive Music Therapy reduces anxiety more effectively than active participation in Interactive Music Therapy due to the more relaxed and stress-free nature of the tasks. However, different modalities need to be matched to patient profiles to produce the most beneficial results. For example, patients with limited mobility may be better suited for Receptive Music Therapy, while others with stronger cognitive capacity may be drawn to Interactive Music Therapy. It is possible that receptive and interactive therapies can work together, customized to the patient's individual needs and conditions.

Rhythmic Auditory Stimulation uses rhythmic cues to improve motor timing and coordination. Rhythmic cues can help bypass damaged neurological pathways, offering greater benefits and recovery. Compared to other stimuli in music therapy such as melody, harmony, and timbre, rhythm stimulates greater movement and brain activity, and has wide functionality. One study found that when patients with traumatic brain injury performed rhythm training and assisted playing, it improved cognitive and behavioral functions (Martínez-Molina et al., 2021). In addition, the use of Rhythmic Auditory Stimulation on patients with Parkinson's Disease found significant improvements in gait, speed, and movement control (Raglio, 2015). Although the patient populations and conditions differed, the consistent behavioral improvements underscore the potential benefits of using Rhythmic Auditory Stimulation across all neurological disorders. Dopamine is a neurotransmitter essential for movement control and mood regulation. In Parkinson's disease, a loss of dopamine leads to motor depletion, particularly tremors and bradykinesia, and instability. However, when patients undergo Rhythmic Auditory Stimulation, the rhythm links motor symptoms with external timing cues. The rhythmic cues compensate for loss of dopaminergic stimulation, allowing patients to overcome impaired internal timing functions. Current research largely focuses on short-term, cue-dependent improvements of Rhythmic Auditory Stimulation. Further experiments are needed to find patterns of its long-term effects on motor and cognition. Combining Rhythmic Auditory Stimulation with other more behavioral or emotionally oriented therapies can lead to great benefits in thorough patient recovery from neurodegenerative disorders.

How Various Aspects of Music Therapy target Specific Cognitive Functions

Musical elements, such as genre and tempo, significantly shape cognitive and behavioral outcomes in music therapy. Differences in musical elements influence various aspects, including engagement, memory, and motor control.

In a recent review assessing the current understanding of music preferences on cognition in various mental health conditions, it has been shown that familiar or preferred music can elicit improvements in cognition (Rajakumar & Mohan, 2024). When coma patients listened to their favorite music, it led to an increase in consciousness (Carrière et al., 2020). Furthermore, patients with consciousness disorders experienced cognitive reactivity when listening to their preferred music (Castro et al., 2015). Similarly, preferred music brought greater pleasure to patients with Parkinson's disease compared to other pieces of music (Morris et al., 2019). The effect may stem from the way preferred music evokes aspects of emotional saliency associated with the music, which allows for reduced cognitive effort and corresponds to cognitive benefit.

Other studies have examined the effects of music genre on listening comprehension (Harmon et al., 2009). A group of 27 students was randomly assigned into one of three groups: Classical, Rock, or Silence; they listened to their assigned condition for ten minutes, then listened to an article and completed a quiz about the article. Although the changes in test scores were not significant (Mozart 66.7%, Rock 50%, Silence 50%), students who listened to Mozart generally performed better than students who listened to rock or silence. The finding supports the theory of the "Mozart effect," which suggests that listening to Mozart's music can improve cognitive performance. However, mixed empirical results highlight the variability in these outcomes. In a similar experiment testing reading comprehension, students who worked in silence performed better on the reading comprehension quiz compared to students who listened to classical music or rock (Silence 72.22%, Rock 65.56%, Classical 65.56%). These small differences suggest that music may not strongly influence the cognitive performance of people without neurological impairments. Instead, factors such as personal music preference or how well the music fits the individual's current state may play a larger role. Still, certain genres or musical elements might offer specific cognitive benefits. Because the study involved only 27 students, the findings may be less reliable and not fully representative of differences across randomly assigned groups.

Similar to genre, differences in tempo have been shown to have significant effects on patients' behavior and cognition. A study measured how different tempos impacted motor timing in patients with Parkinson's disease (Rose et al., 2019). Patients were asked to tap their toe, finger, and step in place on a marker on the floor in a slow, medium, and fast tempo for music and a metronome. The study found that patients listening to music generally performed better in both synchronization accuracy and pacing stability. Stepping on the spot also led to more stability compared to toe and finger tapping. Researchers concluded that this occurred because stepping on the spot was more natural than other movements, resulting in more precise pacing and synchronization with the music. The finding is significant for movement rehabilitation treatment for patients with Parkinson's, allowing therapists to determine which movements can engage with the brain at different speeds. Tempo allows the brain to synchronize with rhythmic patterns, regulating movement timing. External music cues may help compensate for impaired internal timing in patients with Parkinson's disease, though their effectiveness varies depending on task demands and disease severity.

In conclusion, both genre and tempo affect cognition and behavior, but through different mechanisms. While genre relies heavily on emotional salience and familiarity, tempo leverages rhythmic entrainment to synchronize with patients' impaired internal cues. When tailoring interventions, therapists should consider both genre and tempo to maximize effectiveness across multiple aspects.

How Various Aspects of Music Therapy Target Specific Neural Measures

Music therapy influences the brain in ways measurable by Electroencephalogram (EEG) and Functional Magnetic Resonance Imaging (fMRI) tools, demonstrating how certain aspects of music affect brain activity in distinct ways. Neural results clarify *why* and *how* music therapy works. Such understanding encourages future research efforts to integrate music therapy into treatment and recovery.

Many studies have compared cognitive effects across different genres of music. However, within the realm of classical music, different composers can evoke different cognitive benefits. The brain's responses can be analyzed through Electroencephalogram (EEG), which tracks brainwave patterns and functions. It allows researchers to identify patterns, linking the results to cognition. EEG waves are categorized by frequency-alpha, beta, theta, delta, and gamma waves. In an EEG study examining how different composers affect patients with Parkinson's disease, it was found that different composers produced distinct cognitive impacts (Maggioni et al., 2021). The study compared the brain connectivity of healthy participants compared to Parkinson's patients both at rest, as well as listening to Bach, Mozart and Dona. Listening to Bach magnified the difference between the two groups, as healthy patients had significantly stronger brain connectivity. In contrast, Mozart showed moderate differences between the two groups, and Dona had the smallest disparity. These differences highlight music's ability to engage brain networks and changes in the brain depending on the musical characteristics presented. Compared to the resting states, healthy patients showed an increase in both power and connectivity, while Parkinson's patients experienced an increase in connectivity in the brain. By improving brain flow and restoring connectivity, music can play a key role in compensating for neurological deficits.

Another EEG study highlights how different characteristics in music affect alpha and beta waves (Hurless et al., 2013). The study included five rock songs and five jazz songs, with each one presented at three different tempos (100BPM, 120BPM, 140BPM). When analyzing alpha brain wave activity, it was found that without accounting for preferences in genre, there were no significant effects when changing tempos. However, when the music was organized by preference, there was a significant increase in alpha wave amplitude. Alpha waves are seen in a relaxed awake state, typically recorded at the back of the head. The increase in alpha activity indicates how the brain processes preferred and familiar music more efficiently, tending to lead to reduced effort and greater relaxation. Additionally, the experiment saw an increase of beta amplitudes with increasing tempo across both rock and jazz. Beta waves are prevalent during alertness and concentration. They are seen in the frontal and central regions of the brain. The finding demonstrates how faster music is associated with greater alertness, activating motor areas of the brain more strongly. Ultimately, in music therapy, customizations in genre and tempo are vital in targeting symptoms that are most beneficial to the patient.

In addition to EEG, Functional Magnetic Resonance Imaging (fMRI) measures brain activity and neuroplasticity through imaging. Many studies have been done using fMRI to observe how music therapy can influence neural function in patients with neurodegenerative diseases (Rajakumar & Mohan, 2024). When patients with traumatic brain injury received neurological music therapy, changes were found in their neuroplasticity and connectivity (Martínez-Molina et al., 2021). Post-comatose patients who listened to their preferred music experienced enhanced brain function and increased consciousness (Carrière et al., 2020). In another experiment, patients with memory decline listened to familiar, unfamiliar, and repeated melodies, where fMRI results revealed a reduction in musical semantic memory, and an

increased activation in musical episodic memory (Slattery et al., 2019). These findings highlight music therapy's effects on functional brain changes, demonstrating its potential for long-term recovery.

Music from different genres and composers, as well as changes in tempo, affect brain waves differently. Certain composers, such as Bach, magnified differences in brain connectivity between the healthy and diseased group. Furthermore, faster tempo resulted in more brain activation and alertness. EEG and fMRI studies reveal music's influence on the brain in oscillatory activity and connectivity. Personalization in genre, tempo, and preferences are essential, as they influence neural networks differently. The neural evidence of music therapy's effects on the brain suggest its relevance in clinical applications.

Clinical Applications

An important aspect in music therapy's effectiveness lies in how therapy is individualized to align with one's preferences, history, and neurological profile. Customizing music therapy helps ensure interventions are as effective as possible for each patient's unique needs. In a recent review, several studies demonstrated that simply using patients' preferred music served as a powerful personalization technique that led to improved outcomes in music therapy sessions (Rajakumar & Mohan, 2024). When patients in a coma listened to their favorite music, it led to increased consciousness (Carrière et al., 2020). Furthermore, patients with disorders of consciousness who listened to their preferred music experienced cognitive reactivity (Castro et al., 2015). Alzheimer's patients who listened to familiar 1940s-60s songs experienced nostalgia and recognized meaningful content in the songs (Basaglia-Pappas et al., 2013). It is possible that this occurs because familiarity or preferred music triggers memory networks, reactivates neural pathways, and reduces stress in patients. Beyond personal preferences in music, studies have shown that certain musical structures may have unique cognitive benefits. An EEG study compared brain connectivity when patients with Parkinson's disease listened to Bach, Dona, and Mozart (Maggioni et al., 2021). The study ultimately showed a significant contrast in brain connectivity between healthy participants and patients with Parkinson's. Mozart showed a moderate difference between the two groups, while Dona's music produced the smallest difference between the groups. Such findings highlight music therapy's influence on brain network synchronization, specifically within impaired neural systems. Beyond cognitive impacts alone, music therapy can also complement pharmacological interventions. In a study that compared participants who received music therapy in addition to medication with standard control groups, it was found that participants who received music therapy needed a significantly lower dosage of neuroleptics (Degli Stefani & Biasutti, 2016). Additionally, while the control groups had a significant increase in antidepressant dosages, the music therapy group experienced no significant dosage change. Music therapy may enhance the effectiveness of certain medications and lead to a lower required dosage. It can serve as a complement to non-pharmacological intervention to target certain symptoms such as anxiety, apathy, or depression. Music has the potential to reduce medication needs, thereby reducing the risk of adverse effects from pharmaceutical treatment. The issue is especially relevant for older adults and patients who are more vulnerable to medication-related side effects.

Discussion

Music therapy has been shown to improve cognitive, emotional, and functional symptoms in patients with neurodegenerative diseases. Through multiple studies, patterns have been

found across the benefits of music therapy on patients with dementia, Alzheimer's disease, and Parkinson's disease. In general, Alzheimer's treatment focuses more heavily on emotional engagement and attention, while Parkinson's recovery emphasizes motor functions and stabilization through rhythmic cues. Music therapy engages various neurological mechanisms, which both have emotional and neural effects. It provides an outlet for emotional expression and anxiety reduction. The pleasure patients gain from music therapy stimulates a release of dopamine, activating brain pathways and leading to improvements in learning, attention, and motivation. Emotionally meaningful or familiar music enhances memory retrieval and sustained attention, as stimuli that are emotionally charged tend to be better remembered. By stimulating disturbed areas in the brain more effectively, emotional music strengthens both affective and executive systems in the brain for patients with cognitive diseases. Music's ability to reactivate impaired brain pathways allows it to compensate for lost pathways damaged in patients with neurodegenerative diseases. Beyond cognitive benefits, music therapy boosts motor function and balance. Rhythmic cues facilitate motor entrainment in patients, allowing the brain to synchronize motor function with external rhythm, aiding coordination between motor and cognitive rhythms. By activating and engaging brain networks, music therapy slows cognitive decline in patients, leading to an improved quality of life. As shown by its benefits for both Alzheimer's and Parkinson's disease, music therapy can target various aspects of cognitive and physical decline, aiding patients of differing neurological disorders. However, more studies need to be done to assess if these benefits can be sustained over time.

Music therapy's neural effects can be shown through EEG studies on alpha and beta brain wave activity shifts. Imaging evidence from studies demonstrates how music regulates brain activity and compensates for damaged pathways. Alpha waves reflect relaxation and memory retrieval, while beta waves indicate alertness and motor readiness. Different tempos modulate alpha and beta wave activities, influencing cognitive states. These neural measures can be used by doctors and therapists to guide personalization of therapy and measure its effectiveness. During therapy sessions, clinicians can monitor changes in specific brain wave power levels as indicators of the success of music therapy intervention. EEG can provide real-time measurements of engagement or overstimulation, allowing therapists to adjust therapy methods or techniques. Patients may react differently to varying tempos or dynamics based on different factors, such as their own preferences and the context in which they are listening to music. Therefore, dynamic optimization is ideal for individualizing therapy for specific patients. Future studies could assess whether EEG activity from music therapy corresponds to sustained improvements in patient well-being.

Different music therapy techniques allow music to trigger and engage specific areas of the brain, resulting in vastly different outcomes. Receptive Music Therapy, associated with passive listening, helps calm anxiety and supports emotional processing. Its relaxing approach increases alpha wave activity and helps reduce apathy and anxiety in patients. Because of its minimal concentration needed, Receptive Music Therapy may suit lower-energy patients with more moderate disease states. In contrast, Interactive Music Therapy uses active music-making activities, stimulating the motor cortex and prefrontal areas of the brain. It often increases beta wave activity, leading to greater motor control and social interaction. It may be more suitable for patients with early or moderate disease stages, as it requires more engagement and attention. Different therapy techniques should be tailored to each patient based on their condition and stage of disease to maximize their benefits and impacts. A possible approach for moderate to severely impaired patients could be to start with Receptive Music Therapy to improve mood and

the quality of life. Afterwards, once they regain enough focus and social competence they could transition into Interactive Music Therapy to target emotional regulation and motor function.

Depending on patients' conditions and disease stage, patients respond differently to music therapy treatments. Such responses are shaped by disease stage, familiarity, and individual preferences, such as cultural or ethnic music. Specifically, familiar music may reactivate autobiographical memory networks, resulting in an increase in alpha wave activity. Additionally, in many cases, music that ties into a patient's religion has deeper social meaning, fostering a sense of identity and belonging. These types of music enhance dopamine release and limbic system engagement, evoking stronger responses. However, due to memory loss from neurological diseases, musical preferences may be more difficult to identify. By intertwining both memory and emotion, certain types of music have greater effects on patients' overall well-being. Music that optimizes cognitive function must align with the patient's individual needs, experiences, and cultural background, which can be individualized through patient interviews and systematic adaptations based on preceding therapy sessions. These customizations allow the music to have a more profound personal meaning, reducing anxiety and improving mood. Thus, the need for personalization and flexible therapeutic design is crucial in music therapy.

Studies highlighting its benefit suggest that music therapy has potential in complementing medication and physiotherapy in rehabilitation and treatment for diseases. By improving mood and depression, music therapy can reduce medication dosages to minimize adverse effects from drugs. The increased dopamine release patients experience from music therapy can also increase patient responsiveness to dopaminergic drugs. Furthermore, music therapy increases motor engagement, allowing patients to be more receptive to physiotherapy. Currently, there is limited research on the effects of specific aspects of music therapy. Larger sample sizes, more standardized protocols, and more longitudinal studies are essential to assert and evaluate the effects of music therapy, specifically over a sustained period of time. Further studies can isolate a specific characteristic of music therapy and control other parameters to link its effect to differences in outcomes. These qualities include personalization elements such as genre, tempo, harmonies, and sound range. Given music therapy's future potential, its integration with pharmacological treatments, physiotherapy, and cognitive rehabilitation should be further researched and more widely implemented.

Conclusion

Music therapy provides a rare combination of emotional fulfillment and neurological benefit. It is both a tool for neural rehabilitation and a deeply human experience. Its accessibility and innocuousness make it suitable for long-term care and use. Embracing both the clinical and humanistic aspects of music therapy can truly transform the trajectory of recovery for individuals.

In the future, with the development of new technologies, music therapy can take on new directions that increase its accessibility and effectiveness. EEG-guided adaptive interventions provide real-time feedback, and AI-generated playlists can adapt selections based on prior responses. VR music therapy activates the motor and sensory systems, enhancing music therapy's engagement. However, these new technologies may increase costs and reduce accessibility. They also underscore the essential need for human connection in music therapy, as relying only on technology may diminish the emotional resonance and relationships built through music. Ultimately, music therapy can reshape clinical care models, making treatment more customizable and patient-centered, and redefine treatment for patients with

neurodegenerative diseases. Music therapy bridges the gap between clinical science and human experience, creating holistic therapy care focused on recovery and healing.

However, music therapy's benefits are not limited to patients with neurodegenerative diseases. Music can reduce stress, improve mood, and regulate emotion. It has the ability to improve emotional, cognitive, and physical well-being in people across a wide range of ages and conditions. Music is, at heart, a versatile tool that can be used across multiple health contexts to heal, comfort, and improve people's daily lives.

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