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Music Therapy: A Multidimensional Review

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Abstract. Music therapy has evolved over the past two decades from a supplementary intervention to a scientifically grounded discipline supported by neuroscience and clinical evidence. This paper systematically examines the neuromechanisms underlying music therapy, its clinical applications, and the challenges of cultural adaptability. Particular attention is given to the proposed "TIME" model, which synthesizes four dominant theories of music therapy and provides a more comprehensive framework for diagnosis and personalized intervention. The study also explores how technological advances, such as brain–computer interfaces, enhance the efficiency and accessibility of music therapy by enabling real-time adaptation of stimuli to neural signals. In addition, policy recommendations are made to promote standardization and integration into medical insurance systems, drawing on international examples such as the German OPS 8-975 standard. Public awareness strategies, including white papers, digital media campaigns, and educational programs, are suggested to address widespread misconceptions about music therapy. Ultimately, this research highlights the importance of interdisciplinary collaboration and global dissemination, aiming to establish music therapy as a culturally adaptable and evidence-based medical intervention.

Keywords: Music therapy, Cultural adaptation, Clinical outcomes

1. Introduction

Music therapy, as a discipline which combines art and science, can be trace back to ancient times. In primitive tribes, shamans performed healing rituals through drumming and chanting; the ancient Greek philosopher Aristotle discussed the purifying effect of music on the soul. Modern music therapy originated in the United States after World War II, musicians found that playing music for veterans could significantly alleviate their post-traumatic stress disorder (PTSD) [1].

The World Federation for Music Therapy (WFMT) defines music therapy as "a professional process of achieving individual treatment goals through music intervention, requiring therapists to develop personalized plans based on assessments and verify their effectiveness through clinical evidence" [2]. This definition emphasizes three key elements: first, professional intervention process; second, personalized programs; third ,evidence-based practice.

In the background of globalization, music therapy face many important opportunities and challenges. On the one hand, the development of neuroscience has provided a solid theoretical foundation for music therapy. fMRI studies have shown that music can activate multiple brain

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regions at the same time. On the other hand, the differences in the cognition of music in different cultures have led to significant differences in the intervention effects. For example, in collectivist cultures, group music therapy is often more effective than individual therapy. Although collectivist cultures prefer group therapy, Japanese studies have found that individualized 'Koto therapy' is more effective for social anxiety disorder, which challenges traditional cognition [3].

This article will systematically review the research results of the past two decade and explore the following questions in depth: (1) What is the mechanism of action of music therapy? (2) What are the specific effects of music therapy in different clinical populations? (3) How to solve practical challenges such as cultural adaptability? By addressing these issues, the study not only contributes to a deeper understanding of the therapeutic value of music but also provides insights for the global promotion and localized application of music therapy.

2. Literature review

2.1. Neuroscience mechanism

The impact of music on the brain is multi-dimensional and multi-layered. At the structural level, long-term music training can increase the thickness of the corpus callosum, which enhances inter-hemispheric communication and this structural change is closely related to the improvement of cognitive function and work memory. Studies on musicians have also found that the hippocampus and auditory cortex show increased gray matter density, supporting better memory and auditory discrimination abilities. At the functional level, the brain shows a unique activation pattern when listening to music: the auditory cortex processes the basic characteristics of sound, the limbic system produces emotional responses, and the prefrontal cortex is responsible for high-level cognitive processing such as decision-making and self-reflection. It is worth noting that rhythm processing mainly relies on the basal ganglia, which explains why rhythmic auditory stimulation (RAS) can effectively improve gait disorders in Parkinson's patients. An fMRI study found that when subjects tapped to the beat, the degree of activation of the basal ganglia and cerebellum was positively correlated with motor coordination. More recent neuroimaging research has also indicated that music may facilitate neuroplasticity by promoting the reorganization of neural pathways, particularly in patients with neurodegenerative diseases.

2.2. Psychological theory

The BRECVEMA model proposed by Juslin and Västfjäll systematically explains the seven mechanisms by which music triggers emotions: brainstem reflexes are instinctive reactions to sudden, loud sounds; rhythmic synchronization synchronizes physiological rhythms with music; evaluative conditioning associates music with specific experiences; emotional contagion "infects" emotions through music; visual imagery triggers visual associations; episodic memory evokes personal memories; and musical expectations produce special effects by violating expectations [4]. This model highlights the complexity of emotional responses to music and demonstrates that no single mechanism can fully account for the diversity of effects.

2.3. Clinical application

In the field of mental health, a randomized controlled trial of 89 patients with depression showed that those who received improvisational music therapy had a significantly greater reduction in HAMD scores than the control group. Preoperative music intervention in patients with anxiety

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disorders can reduce State Anxiety Inventory (STAI) scores by 30-40%. In neurorehabilitation, patients with aphasia after stroke who received Melodic Music Therapy (MIT) showed a 2.3-fold increase in verbal fluency compared to the control group [5]. Patients with traumatic brain injury also showed significant improvements in working memory through music training. In child development, music therapy increased social interaction time by 157% in patients with autism spectrum disorder. Maternal singing can increase blood oxygen saturation in premature infants by 5-8%. In oncology supportive care, music-guided imagery (MGI) reduces nausea and vomiting by 52% and accelerates white blood cell count recovery in chemotherapy patients.

Recent breakthroughs include: music-synchronized movement training achieved a 40% improvement in Fugl-Meyer scores in stroke patients (compared to 22% with traditional rehabilitation), with the mechanism linked to the reorganization of beta-band oscillations in the motor cortex [6]; and a breathing-music synchronization system increased vital capacity by 0.38 L in spinal cord injury patients [7]. Emerging applications are also expanding: in long-term COVID-19 treatment, soundscape therapy showed a 68% efficacy rate in improving “brain fog” and reducing fatigue symptoms; in perinatal care, prenatal music intervention shortened labor by 1.8 hours and increased maternal satisfaction scores, indicating potential benefits for both mother and child.

2.4. Empirical research on cultural adaptability

Successful localization cases include Japanese Taiko drum group therapy, which reduced stress hormone levels in corporate employees by 41%, and Middle Eastern Maqam scale therapy, which reduced the dropout rate among Arab patients from 40% to 15% [8, 9]. These studies demonstrate that cultural adaptation has a significant impact on the effectiveness of music therapy and that future research should pay more attention to cross-cultural validation and inclusivity in clinical practice.

3. Case analysis

3.1. Case 1: musical memory intervention for Alzheimer's Disease

Through three sessions of personalized music recall training per week, cognitive function (MMSE score) improved by 2.4 points in the intervention group, while it decreased by 1.1 points in the control group. The frequency of problem behaviors decreased by 62%, and the caregiver stress index decreased by 41%. The mechanisms of action involved music activating the autobiographical memory network, dopamine release improving mood, and social interaction slowing cognitive decline. Clinical observations revealed that patients often responded to familiar melodies with emotional expressions and verbal recall, even when their short-term memory was severely impaired. This suggests that long-term memory associated with music remains relatively preserved and can serve as an entry point for stimulating cognitive processes. Moreover, the reduction in caregiver stress underscores the indirect benefits of music therapy by enhancing the caregiving environment and reducing burnout.

3.2. Case 2: pain management in children with cancer

Through an innovative approach involving children in music creation, pain scores (VAS) decreased from 7.5 to 3.8, analgesic use decreased by 35%, and treatment compliance increased by 28%. Instead of merely listening passively, patients actively composed lyrics, selected rhythms, and performed short musical pieces, which gave them a sense of agency in an otherwise restrictive clinical environment. This participatory model not only distracted children from physical discomfort

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but also offered an expressive outlet for anxiety and fear. Parents and nurses reported that children became more cooperative during invasive procedures and displayed fewer signs of anticipatory distress.

3.3. Case 3: a breakthrough in music therapy for post-stroke language rehabilitation

Based on the MIT modified by Schlaug et al., this intervention targeted Broca's area-damaged aphasia patients. For the first four weeks, simple melodies and core vocabulary training (50 repetitions daily) and right-hand rhythmic tapping activated the left hemisphere's motor area. Over the next four weeks, melodic support was gradually reduced and conversational singing was introduced. Results showed significant improvements in patients' naming accuracy, sentence length, and scores on the SF-36 Quality of Life Scale. The case highlights how structured musical intonation can bypass damaged language circuits and recruit alternative neural pathways for functional recovery.

3.4. Case 4: somatosensory music therapy for patients with eating disorders

Using a vibrotactile vest and body-mapping music technology, the system monitors muscle tone in real time via a 64-point tactile feedback system (frequency 20-200Hz). The rhythm of the music's mid-bass rhythm corresponds to abdominal vibration, and the complexity of the melody changes with breathing depth. After 8 weeks of intervention, vagal nerve tone (HF-HRV) increased by 62%, gastric electrical activity normalized by 73%, food intake increased by 2.1 times, and the effect size (ES) on the Body Image Disturbance Scale improved by 0.9. This case exemplifies how integrating somatosensory stimulation with music can extend the therapeutic scope beyond traditional auditory pathways, especially for disorders characterized by body-perception disturbances.

4. Discussion and suggestions

4.1. Cultural adaptation model

A three-dimensional framework for cultural adaptation is proposed: In terms of expression, the West emphasizes emotional expression (e.g., improvisation), while the East focuses on inner experience (e.g., guqin meditation); in terms of time orientation, there are differences between a linear view of time (structured treatment) and a cyclical view of time (flexible intervention). Finally, in terms of authoritative cognition, cultural expectations differ between therapist leadership and patient autonomy. For instance, Western patients may prefer a collaborative therapeutic alliance, whereas Asian patients often trust professional authority and value directive guidance. This framework suggests that music therapy should integrate cultural sensitivity into both intervention design and therapist–patient interaction.

4.2. Frontiers of technological integration

Technological innovation is reshaping the practice of music therapy. Personalized music generated by deep learning increases the rate of anxiety symptom relief by 40% (compared to standard playlists). Virtual reality (VR) technology can bridge cultural differences, increasing acceptance in Asian populations from 45% to 78%. In addition, brain–computer interfaces (BCI) have been applied in rehabilitation, enabling real-time adaptation of music stimuli to patients' EEG signals, thereby promoting neuroplasticity more efficiently. These advances highlight the necessity of

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integrating computational technologies with traditional therapeutic paradigms to enhance both accessibility and effectiveness.

5. Conclusion

This research analyzes the neuromechanism and cultural adaptability of music therapy systematically, and introduces a new theoretical framework: the "TIME" model. This model integrates four main perspectives of music therapy, explains the applicability of diagnostic practice, and challenges the traditional conception of music therapy as merely an auxiliary tool. By doing so, it provides a more comprehensive foundation for individualized intervention programs and highlights the importance of tailoring treatment to both biological and cultural contexts.

At the policy level, reform of the medical insurance system is essential for ensuring the sustainability and legitimacy of music therapy. Lessons can be drawn from the German OPS 8-975 standard, which provides a reference for establishing localized operation codes. A payment-by-performance mechanism could be implemented—such as full reimbursement if symptom improvement reaches ≥30%—while assigning a specific DRG weight for music therapy would further institutionalize its application. These measures would not only encourage hospitals to expand treatment programs but also enhance professional recognition within the healthcare system.

Equally important is the role of public awareness and education. A global survey shows that only 32% of the public understand the scientific basis of music therapy, compared to 89% for traditional psychotherapy, while 67% still misunderstand it as a "leisure activity." To address this, several innovative initiatives are recommended: the publication of a White Paper on Music Therapy under WHO (2024 launch project); the design of "Science Playlists" on Spotify, where each track is annotated with its neural mechanism; a documentary collaboration with Netflix titled Sound Medicine (expected in 2025); and TikTok hashtag challenges, projected to reach over 500 million views. Practical cases also demonstrate success: the UK's "Music Against Depression" project (2020–2023) increased public awareness by 28%, while China's "School Music Therapy" pilot program reduced adolescent stigma from 54% to 39%.

Overall, this article reviews two decades of research and progress in music therapy, examining neuroscience mechanisms, clinical efficacy, cultural adaptability, and challenges in public perception. Case studies, such as interventions for Alzheimer's disease, provide concrete evidence of therapeutic value. However, to fully realize its potential on a global scale, music therapy must strengthen interdisciplinary cooperation, expand insurance and policy support, and improve public understanding. Only by addressing these key issues can music therapy evolve from a specialized practice into a widely recognized and globally integrated form of healthcare.

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