

The Future of Music in Therapy and Medicine

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ABSTRACT: The understanding of music's role and function in therapy and medicine is undergoing a rapid transformation, based on neuroscientific research showing the reciprocal relationship between studying the neurobiological foundations of music in the brain and how musical behavior through learning and experience changes brain and behavior function. Through this research the theory and clinical practice of music therapy is changing more and more from a social science model, based on cultural roles and general well-being concepts, to a neuroscience-guided model based on brain function and music perception. This paradigm shift has the potential to move music therapy from an adjunct modality to a central treatment modality in rehabilitation and therapy.

KEYWORDS: music; neuroscience; aesthetics; neurologic music therapy

FOUNDATIONS IN AESTHETICS AND NEUROSCIENCE

The study of the neurobiological basis of music has intrinsically linked music to a role in influencing and shaping brain function. The brain—one may state—that engages in music is changed by engaging in music. This reciprocal relationship in music and brain function has been discovered over the past 10 years by connecting the fields of neuroscience, music cognition, music therapy, and rehabilitation. The connection has unfolded within the larger context of a very fascinating line of research demonstrating the experience-dependent plasticity of the brain, which is one of the most powerful motors of change in the understanding of learning, cognition, and therapeutic rehabilitation. In the modern history of music therapy—encompassing roughly the past 60 years—social science concepts of music's influence and role in human life and society have dominated music therapy. The therapeutic value of music was explained mainly by music's cultural role in facilitating social learning and emotional well-being. However, more recently—under the influence of new data in brain research in music—new findings suggest that music can stimulate complex cognitive, affective, and sensorimotor processes in the brain, which can then be generalized and transferred to nonmusical therapeutic purposes.

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These research developments fit surprisingly well with developments in aesthetics and psychobiology that help our understanding of the role of art works in perception. One of the key concepts suggested in aesthetic perception is the function of the mediating response, as described for the first time comprehensively by Berlyne in 1971.¹ Berlyne contends that aesthetic (sensory) stimuli can have a facilitating, clarifying, organizing, and amplifying function in the perception and analysis of nonaesthetic objects and behavior experiences. Furthermore, they can facilitate and enhance the development of adequate and adaptive responses to such objects and experiences.

The concept of music as a mediating stimulus is a useful one for music in therapy, because it locates the musical response and musical stimulus as a mediator among current brain and behavior function, the aims of therapy, and the desired therapeutic response. In experimental aesthetics the mediating response in music is caused by the meaningful perception of the intrinsic patterns in the music itself, as well as by other symbolic, iconic, or behavioral meanings that have become linked to the music through associative learning processes. As a mediating stimulus, music—based on its uniquely ordered structure of sensory patterns in aesthetic forms—initially engages human behavior and brain function meaningfully by arousing, guiding, organizing, focusing, and modulating perception, attention, and behavior in the affective, cognitive, and sensorimotor domains. From these premises we can build research models that show how music can influence human behavior and brain function in general as well as in a therapeutically meaningful way. Interestingly, a renewed and complex focus on the aesthetic foundations of music perception and music production has provided the key to a firm rooting of the future of music therapy in the neurosciences.

HOW RESEARCH TRANSFORMS CLINICAL PRACTICE

A brief review will illustrate how these concepts have served since the early 1990s as a foundation for a new research agenda that is scientifically explanatory as well as translational and foundational to a new clinical practice in music therapy.

Studies have shown impressively over the past 15 years that rhythmic entrainment of motor function can actively facilitate the recovery of movement in patients with stroke,^{2–7} Parkinson disease,^{8–14} cerebral palsy,¹⁵ or traumatic brain injury.¹⁶ There is strong physiological evidence that rhythmic sounds act as sensory timers, entraining brain mechanisms that control the timing, sequencing, and coordination of movement. Recovery of speech functions can also be facilitated with music.^{17–22} Music's strong timing mechanisms are thought to entrain oscillatory circuits in the speech centers of the brain.²³ Recognizing the importance of temporal organization in cognitive functions, new frontiers in research have investigated the effect of music and rhythm on critical aspects of timing in learning, attention, executive function, and memory.^{24–33}

In a fascinating analogy, it may be suggested that music—written in the time code of rhythm, creating meaningful sound patterns in time—simulates or resembles the oscillatory “rhythmic” synchronization codes of neural information processing in the brain, thus becoming a powerful stimulus to communicate sensory and cognitive-perceptual information to the brain.³⁴ Music's temporal-based grammar may be in

fundamental parallel to how the brain processes information. Neurophysiological studies have shown that sound can arouse and excite the spinal motor neurons mediated by auditory-motor connections at the brain stem and spinal cord level.³⁵ This priming effect sets the motor system in the brain in a state of readiness, facilitating the execution of movements. However, rhythmic sounds also entrain the timing of the muscle activity, thereby providing a physiological template for cueing the timing of movements. Patients with neurological movement disorders do benefit from this effect of music and rhythm to retrain their motor functions. Thus, music provides a stimulus that substitutes for compromised internal functions, accesses compensatory networks in the brain, and may help build new pathways shaping the plasticity of the brain. The rhythmic patterns of music can help patients with Parkinson disease overcome bradykinesia and episodes of “freezing” of movement because the music acts as a sensory sequencer that provides critical neural “movement” command signals that are not generated reliably in time by brain areas affected by the disease.^{18,36}

In cognition, we may consider as an example the effect of music on memory. The organizing element of chunking, a critical element in memory coding, is always present in all music as a necessary component to build musical forms through melodic, harmonic, and rhythmic phrasing.³⁷ Studies have shown that music can function as an excellent memory template for nonmusical declarative or procedural learning.^{38–40} Studies with memory disorders, such as Alzheimer disease (AD), frequently show retention of musical information in patients that is preserved longer and out of proportion with their concurrent state of memory loss.⁴¹ Such data suggest that neuronal memory traces built through music are deeply ingrained and more resilient to neurodegenerative influences.^{27,28} Findings that in memory tasks people with AD access prefrontal-amygdaloid networks rather than prefrontal-hippocampal networks may make music a useful modality to access and enhance memory function in AD, based on its highly emotional saliency.⁴² The organizational basis of music as a temporally “overstructured” language of sound patterns may play a critical role in such effective memory formation.⁴³ Recent research has shown that neuronal oscillations, which build rhythmically synchronized firing patterns in network ensembles of neurons, form the neurobiological basis of perception and learning. The precise synchronization of neuronal activation patterns is a crucial element in building the tightly coupled networks that physiologically underlie the process of effective learning.⁴⁴ Thus, music’s temporality, expressed in its rhythmic nature, may optimize the formation of such rhythmic neuronal networks, because music, as the learning stimulus that drives the physiological activations in the brain, is already tightly organized within temporal structures.⁴⁵

CONCLUSION

Music can communicate information to the brain that has profound effects on learning, development, recovery of function, and aesthetic engagement. Research into the neurobiology as well as biomedical effects of music has made great and unprecedented progress in the last decade due to a fruitful merger of lines of investigation from neuroscience, psychology, medicine, psychophysics, and musicology, supported by other disciplines, such as mathematics, physics, and engineering.^{46,47}

A large number of clinical studies have shown striking evidence that auditory rhythm and music can be effectively harnessed for specific therapeutic purposes. The emerging research base has guided the establishment of neurologic music therapy as a comprehensive new clinical model of music therapy practice that has found recognition and acceptance as an evidence-based rehabilitation discipline.

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