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A Brief Review of Neurological Music Therapy: A Promising Tool for the Autonomic Nervous System

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Dysautonomia has caused immense suffering to many individuals and impacts quality of life to the point of being unable to maintain activities of daily living. Anxiety, blurry vision, bowel issues, brain fog, dizziness, exercise intolerance, insomnia, tachycardia and low blood pressure are some of the symptoms that incapacitate sufferers, leading to depression and a higher risk of suicide in many individuals. From familial genetic heritage to pediatric brain injury, there are many causes cited for autonomic nervous system (ANS) disorders like dysautonomia. Treatment for the ANS is proving elusive although it is estimated that 1 out of every 100 teens has dysautonomia and the numbers are continuing to rise.

Neurological Music Therapy (NMT) is a non-invasive holistic modality that shows promising impact for autonomic nervous system disorders. NMT is defined as the therapeutic application of music to cognitive, affective, sensory, language, and motor dysfunctions due to disease or injury to the human nervous system. It is based on neuroscience and the influence of music on changes in the brain. More recent research has been done specifically on the tone or frequency of music, proving a fascinating reciprocal relationship between music and the autonomic nervous system. Through NMT, the brain can train and retrain the non-musical brain and behavior functions to include re-establishing a feeling of safety so that the body may revert the cell danger response. That said, continued research and work within the field of NMT may reveal a common finding: that the ANS serves as the final common pathway by which music exerts a therapeutic effect on health and disease.

Introduction

Music as a therapy to impact the human body has existed for thousands of years. One of the earliest recorded incidences of music as therapy was recorded in approximately 600 BC in *The Holy Bible: English Standard Version*[1]: “And whenever the harmful spirit from God was upon Saul, David took the lyre and played it with his hand. So Saul was refreshed and was well, and the harmful spirit departed from him” (1 Sam. 16:23). In more modern times, the investigation of the impact of music on human physiology dates back over 125 years, with 24 investigations being cited between 1880 and 1918 alone[2]. The majority of modern music therapy has mainly involved social science concepts of emotional and social roles. The role of music therapy took a dramatic shift in the 1990’s when cognitive neuroscience began to comprehend the impact of music as a tool that did more than improve well-being. Numerous studies accounting the impact of music on individual parameters such as heart rate, blood pressure, respiratory rate and electrodermal response emerged. Additionally, a few studies began to investigate the impact of music on endocrine and immune system functioning[2]. As a result, music therapy is now moving from being an adjunct therapy to a core treatment modality known as neurological music therapy (NMT).

“NMT is defined as the therapeutic application of music to cognitive, affective, sensory, language, and motor dysfunctions due to disease or injury to the human nervous system”[3]. It is based on neuroscience and the influence of music on changes in the brain. The treatment techniques are standardized in terminology and application based upon scientific research. Practitioners are trained in music and neurological music therapy as well as neuroanatomy & physiology,

neuropathology and modalities of rehabilitation of cognitive, speech and motor functions. Based upon research from the past decade, science is soundly demonstrating that NMT applied within a neuroscientific framework effectively impacts the autonomic nervous system (ANS).

The Autonomic Nervous System is a complex neurological complex “that mediates internal homeostasis without conscious intervention or voluntary control. Cells of the ANS innervate all viscera and influence their activity locally as well as mediate global changes to the metabolic state”[4]. The ANS regulates blood pressure, breathing rate, heart rate viability as well as influences digestion, urination, and sexual arousal. More specifically, the ANS includes cranial nerves I-XII with specifically the vagus (Cranial Nerve X), known as the “PolyVagus” nerve that contains a dorsal and ventral branch system that have very divergent functions first proposed in 1994 by Steven Porges[5]. The dorsal branch of the vagus nerve reacts to stress of life-threat through immobilization or feigning death. Neurobiologically this is an unmyelinated pathway originating from the dorsal nucleus of the vagus nerve. To use this pathway requires a massive shut-down of the ANS via a vagal pathway in the parasympathetic nervous system. The second vagal pathway, the ventral branch, has the capability to regulate fight-or-flight. The ventral branch originates in the nucleus ambiguous, is myelinated, and interacts in the brain stem with the structures regulating the striated muscles of the face and head. The ventral vagus branch travels primarily to organs above the diaphragm whereas the dorsal branch travels primarily to organs below the diaphragm.

“Gut feelings” and “heart-felt perceptions” are the dominion of the vagus nerve. Sensory stimulation from playing or listening to music impacts the vagus nerve. Signals are sent to the medulla and the forebrain areas via the insula (which elicits emotional responses) as well as influencing social neuropeptides like oxytocin and vasopressin along with the immune system[6]. Recently it was discovered that there is a link between the vagus nerve and the cell danger response (CDR) mechanism in the human body. Dr. Robert Naviaux wrote, “When the normal cyclic variations in vagal outflow are chronically disrupted during cell danger response (CDR) from chronic stress, trauma or illness, a number of autonomic abnormalities occur that result in disinhibiting the sympathetic nervous system.… Metabolic memory of past experiences primes the cellular response to future exposures, even when the original trigger or stress is no longer present”[7]. While Naviaux’s identification of mode of mechanism is insightful, he wasn’t the first to note a “paralyzed” parasympathetic nervous system. Hippocrates noted, “If a fright or despondency lasts for a long time, it is a melancholic affection”[8]. In effect, the body becomes “stuck” in sympathetic and cannot revert back to parasympathetic without specific-targeted support that appropriately stimulates the vagus nerve through physical movements or listening activities.

The stapedius muscle, innervated by cranial nerve VII, is the smallest muscle in the body and plays a big role in hearing. It’s role in Polyvagal theory is extremely significant. In order to recover individuals from CDR and appropriately stimulate the vagus nerve, Theresa Benson developed a Listening Project Protocol to successfully treat autistic children[9]. Alfred Tomatis, an Ear-Nose and Throat Doctor (ENT), has developed the Electronic Ear Listening Fitness Trainer (LiFT) along the same principles in order to treat autonomic nervous system disorders to include concussions, etc.[10]. Stimulation of the stapedius through the facial (cranial nerve VII), along with the trigeminal (cranial nerve V) and the glossopharyngeal (cranial nerve IX) by singing or playing a musical instrument stimulates several components of the ventral vagus nerve, helping the body to reverse being “stuck” in fight-or-flight. Unsticking the ventral vagus branch then permits the dorsal vagus branch to allow the digestive tract to return to rest and then digest.

Virtually all chronically ill patients, along with trauma victims and wounded warriors have come to feel betrayed by their body, their families and by the community. In short, they do not feel safe. As Dr. Naviaux[7] stated in CDR, an organism cannot heal itself if it doesn’t feel safe. Functional Medicine practitioners who are working with patients diagnosed with auto-immune conditions that include a mast-cell activation disorder that causes hyper-inflammation, believe music, particularly singing or playing an instrument, helps re-establish the gut-brain axis and allows the body to feel

safe. Dr. Peter Levine[11] demonstrates this principle by teaching patients to sing, "Voooooooo….". Datis Kharrazian utilizes a similar principle by teaching patients to listen to music on headphones and sing aloud[12].

While there is human physiology evidence to support the use of music from an auditory as well as a performance impact on the ANS via the Polyvagal Theory, there is a need for more scientific research studies that demonstrate the impact of specific types and frequencies of music on the ANS. Is all music the same or does it make a difference as to the type, tone and/or pace of the music? While there are numerous studies that elaborate on the emotions elicited from music, there are few studies that specifically evaluate the impact of tone, type and/or pace of the music on the ANS.

Many individuals are familiar with the "Mozart effect," a misquoted study that linked listening to Mozart to increased intelligence. Soon, baby Mozart CD's were being played by parents eager to improve their children's intellectual capacity. While the results of the study in 1993 by Rauscher, et al.[13] were strongly misconstrued, there was something to be gained from the impact of music on spatial reasoning. Further studies since that time have demonstrated that learning to play music prior to age 7 has an impact on language assimilation and processing- even if the individual no longer plays an instrument[14]. More recent research has been done specifically on the tone or frequency of music, specifically Mozart K.448. In 2010, researchers studied epileptic pediatric patients via electroencephalogram before, during and after exposure to Mozart's Sonata for two pianos in D major, K.448 (piano K.448) and the frequencies of their epileptiform discharges were compared. The results found that interictal discharges were reduced in most (81.0%) patients as they listened to the piano K.448 (more fundamental tones and lower harmonics)[15].

The Mozart K.448 epileptic research article led to a study in the fall of 2018 on the "Effect of 528 Hz Music on the Endocrine System and Autonomic Nervous System"[16]. The study examined the stress-reducing effect on the endocrine system and the ANS by using "healing" music at 528 Hz, otherwise known as solfeggio frequency music. Salivary biomarkers of stress (cortisol, chromogranin A and oxytocin) were measured along with continual monitoring of the ANS through the measurement of heart rate variability after 5 minutes of listening to the specific frequency of music at the same time on different days. Based on the salivary biomarkers of stress, the 528 Hz group experienced a statistically significant drop in stress markers, indicating a reduction in stress on the endocrine system. Further, while both groups experienced a change in heart rate variability, only the 528 Hz group experienced a statistically meaningful increase in their focus as they were relaxing. Finally, the 528 Hz group showed a decrease in tension-anxiety. In short, while the study was limited in size, it demonstrated that tone does make a difference and the data provides support for neurological music therapy as a tool to influence the ANS.

Similarly, research of significant note has been done on the type of music and the impact on ANS in the hospital setting. A study by Trappe on the role of music in intensive care medicine in 2012 concluded,

The most benefit from music on health and therefore on the intensive care patient is seen in classical and in mediation music, whereas heavy metal or techno are ineffective or even dangerous. There are many composers that effectively improve health, particularly Bach, Mozart, or Italian composers. Various studies suggested that this music has significant effects on the cardiovascular system and influences significantly heart rate, heart rate variability, and blood pressure as well. This kind of music is effective and can be utilized as an effective intervention in patients with cardiovascular disturbances, pain, and in intensive care medicine[17].

While Trappe's findings appear dramatic, the impact on the ANS is equally dramatic in severely compromised patients who are in an intensive care unit setting.

As clear as the conclusion above appears to be, much of the research in the field of neurological

music therapy is creating more questions than answers. In an article found in the Auditory Cognitive Neuroscience, a section of the Journal Frontiers in Neuroscience, researchers concluded "Further investigations are required to better comprehend how musical stimulation can modify the ANS in patients with severe disorder of consciousness"[18]. The research evidence soundly supports that the ANS is impacted based upon the changes in heart rate variability as well as changes in endocrine function. That said, music listening is an intimate experience and there is a strong individual variability factor that is difficult to study as the degree of complexity of the music along with the current health status of the patient. Additionally, a patient's cultural and experiential history have a significant impact on the interpretation of the music. While classical music by Mozart may help one patient to feel safe and increase their focus, it may trigger extreme irrational anxiety in another due to an unpleasant association with a past experience of a horrifically botched piano recital. Conversely, while some cultural forms of music may remind one person of a yowling cat, it may bring back in another a feeling of comfort and safety from memories of their homeland.

Conclusion

Music is an ancient intrinsic biological language of the human brain[3]. Research is now proving a fascinating reciprocal relationship between music and the autonomic nervous system. Through NMT, the brain can train and retrain the non-musical brain and behavior functions to include re-establishing a feeling of safety so that the body may revert the cell danger response and begin the healing process. Care must be taken, however, as individuals suffering from ANS dysfunctions like multiple chemical sensitivity and mast cell activation disorder are highly sensitive and may not perceive auditory stimuli in a manner that is typical of a healthy individual. They are often expecting to fail treatment regimens as they've seen and tried virtually every therapy there is with minimal success if not modest losses. Often some of the greatest gains are had when these patients are gently moved into neurological musical therapy without even the realization that they are doing so. With respect to experimental studies and clinical application, it is critical to explore how specific features of music trigger ANS responses as the ANS is a part of a sensitive feedback loop. That said, continued research and work within the field of NMT may reveal a common finding: that the ANS serves as the final common pathway by which music exerts a therapeutic effect on health and disease[2].

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