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Modern Science and Ancient Wisdom: Tools for the 21st-Century Musician

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Seth Quay
Intro to Research in Piano Pedagogy
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Modern Science and Ancient Wisdom: Tools for the 21st-Century Musician

Intro

Throughout human history, music has served as a powerful tool for healing, often associated with cultural ceremony, ritual and meditation. The emergence of the Music Therapy profession in the 20th century continues to utilize the medicinal effects of music as an aid in treating psychological and physical ailments. Advanced research methods now allow us to study the brain and nervous system alongside the acoustics of music to discover principles for meaningfully applying music as therapy. How can musicians apply these principles, through practice, performance, programming, and teaching, to reach larger audiences - reaching more than the typical single-person audience of a psychotherapy session?

We can begin to understand the measurable connection between music and the human 'spirit' through the lens of quantum physics. Attempts to explain the extraordinary phenomena of energy and matter in the universe through scientific calculations provides valuable insight into how music can interact with our physical and energetic bodies. Combining research in the fields of psychoacoustics, neuroscience, music therapy, anatomy and quantum physics with ancient wisdom of the human spirit and energy pathways in the body, musicians can make informed decisions about how to practice, how to perform, how to program for various needs of their audiences, and how to holistically meet the needs of their students.

Psychoacoustics and Neuroscience: The Way Sound and Music Affects Us

Understanding the physical properties of sound and how they interact with human physiology and mental processes is useful knowledge for musicians and performers as they strive towards healthy and sustainable approaches to their instrument, and as they prepare for

performances with awareness of how music affects their audiences. The science of psychoacoustics analyzes how the different aspects of sound affect us psychologically. Studies in this field show interaction of sounds waves with physical and mental states of the human body are not limited to what the auditory sense can detect. Furthermore, evidence has proven sound's potential for negative impact on cognitive development and performance as well as emotional sensitivity and mental health.¹ In these instances, environmental sound such as traffic noise or industrial noise impaired mental abilities and induced aggression.² Comparable studies show the positive effects that music can have on cognitive development and performance in infants and students.³ The polarizing effects of various forms of sound requires further study of the nervous system's response to this sensory stimulus.

There are numerous ways music can impact physiological responses, including "heart rate/pulse, skin temperature, respiration rate, blood pressure, muscular tension and posture, blood volume, stomach contraction, pupillary reflex, blood oxygen level, and hormone secretion."⁴ Music can both calm and excite us, activating the fight or flight response or relaxation responses of the central nervous system.⁵ Music can be used to treat stress, yet for some individuals it may induce stress and activate a fight or flight response. The impact of cultural associations and the subjective experience of music and sound creates difficulty in applying music as therapy universally – such as reducing stress in all audience members.

¹ James P. Cowan, *The Effects of Sound on People* (West Sussex, UK: John Wiley & Sons, Inc., 2016), 91-96

² Cowan, 91.

³ E. Glenn Schellenberg, Takayuki Nakata, Patrick G. Hunter, and Sachiko Tamoto, "Exposure to Music and Cognitive Performance: Tests of Children and Adults," in *Psychology of Music* 35, no.1 (Jan., 2007): 5-19

⁴ Cowan, 129.

⁵ Nechama Yehuda, "Music and Stress," *Journal of Adult Development* 18, iss. 2 (June, 2011): 85

⁶ Herbert Benson, John F. Beary, and Mark P. Carol, "The Relaxation Response," *Psychiatry* 37, no.1 (February, 1974): 37-46,

However, some principles of music are experienced very similarly between most individuals, helping to inform decisions about programming and teaching. Artists and performers thoughtfully apply these principles, often concluding recital programs with the most exciting piece or choosing a slow and lyrical piece as an encore to a romantic concerto, after the audience has been taken through a roller coaster of emotions. A teacher must also choose repertoire for their students that is appropriate for their emotional state and stress level.

Music can do more than heighten our emotions and physiological responses. The very foundations of consciousness can be influenced by music through the synchronization of brain waves across hemispheres, inducing altered states of consciousness. Alpha and theta brainwaves associated with deep relaxation and sleep can be increased through simply listening to relaxing music.⁷ The concept of entrainment, used in psychotherapy, also arises in discussions of psychoacoustics and music therapy, describing “the process by which energy in one object is projected onto another to the point where the second object is synchronized with the energy of the first.”⁸ Calming, relaxing music or guided music listening can entrain an individual into a corresponding relaxed state. To employ this concept in the studio, a music teacher may simply place a hand upon an anxious student to project their own calmness and presence. This transference of calming energy helps students to become more present in their own body and aware of excess energy and tension. Entrainment can also apply to mechanical resonance, the physical interaction of the frequencies of sound and our physiological structures.⁹ Mechanical resonance refers to the sympathetic vibration of objects tuned to

⁷ Yehuda, 88.

⁸ Cowan, 129.

⁹ Cowan, 130.

similar frequencies. Studying the mechanical impact of musical frequencies upon our physical bodies could provide additional insights into the basis of music as therapy.

Psychoacoustics can only address *why* we hear what we hear and does not explain “higher-level processes of cognition, emotional response, and behavior.”¹⁰ The application of *systems neuroscience* bridges this gap in understanding through analyzing the neural networks that process and translate stimuli into cognitive, emotional, and behavioral output.¹¹ This allows us to study the affects of music on the “animal brain,” or the survival mechanisms associated with the cerebral cortex, as well as the “lizard brain”, the *phylogenetically* older part of our brain that deals with emotional response (limbic system). Thus, we can begin to understand how music can affect the ‘unconscious’ parts of our mind.¹²

The conscious part of our mind, the “human brain,” can be trained to override the evolutionary survival responses of the “animal brain,” to “plan a behavioral response which is completely independent of the current state of the environment and body, with a goal disconnected from the instantaneous requirements of survival.”¹³ This is a trait that separates humans from animals – the ability to override the “feeling” brain with the “thinking” brain. Musicians can implement this tool of changing the gears of the mind, mediating their response to sensory stimuli to enhance practice, performance, and teaching. This will be investigated further when discussing meditation and music as therapy.

¹⁰ Juan G. Roederer, *The Physics and Psychophysics of Music: An Introduction* (New York: Springer, 2008), 12.

¹¹ Roederer, 12

¹² Roederer, 12.

¹³ Roederer, 13.

Modern neuroscience, the study of the most complex information system known to man (the human brain), concludes that it is unnecessary to describe the function of the human brain in scientific terms while excluding “physically indefinable and immeasurable concepts such as the ‘mind’ or the ‘soul’.”¹⁴ Quantum physics then picks up where neuroscience leaves off in defining these nebulous concepts.

Neuromusicology, also known as Cognitive Neuroscience of Music, has come to define the category of research in music as it relates to the brain and nervous system.¹⁵ Modern technology now allows scientists to observe effects on our brain structures while listening to and producing music. EEG, fMRI, and PET scans allow researchers to peek inside the brain and see what happens when music is heard or produced. The ability to control all variables in the experiment becomes a challenge in these studies. Despite the high resolution and detail of fMRI scans, the machine itself operates at around 60-100 decibels, which is nearing the threshold of healthy human hearing potential.¹⁶ The noise of the machine activates the auditory cortex and is not a reliable way of observing its natural reaction to music.

EEG research is conducted by placing electrodes on the scalp to measure the areas of neural/electrical activity in the brain. It is relatively un-intrusive but less precise than more advanced imaging methods. Despite the imprecision and objective variables, the measurement of brain waves shows that there are levels of awareness and brain activity that are common to all humans and associated with specific frequencies. There are four frequency ranges of brain

¹⁴ Roederer, 14.

¹⁵ Christine Neuhaus, “Methods in Neuromusicology: Principles, Trends, Examples, and Pros and Cons,” in *Studies in Musical Acoustics and Psychoacoustics*, ed. Albrecht Schneider (Switzerland: Springer, 2017), 347.

¹⁶ Neuhaus, 347.

waves associated with four states of consciousness: deep sleep/trance, drowsiness/meditation, a relaxed waking state, and mental activity.¹⁷ As will be discussed later, these variable states of consciousness are reflected in traditions such as yoga and meditation.

Erik Satie aimed to induce a trance state, entering altered states of consciousness through performing the piece 'Vexation'. The composer suggested it be played 840 times on repeat without interruption, resulting in a roughly 28-hour performance. Using an EEG, pianist Armin Fuchs performed 'Vexation' and reported entering a trance state (confirmed by the EEG scans of his brain waves) as well as a shortening and lengthening of time.¹⁸

Neurofeedback is the process of using data retrieved from EEG to consciously modulate brain activity, similar to biofeedback. Trends in psychotherapy have shown incredible results from using neurofeedback to treat psychological ailments such as ADHD and PTSD through conscious regulation of overactive areas of the brain. An interesting application of the EEG in performance and practice has allowed musicians and composers to use neurofeedback to self-regulate different frequencies of brain activity and increase self-awareness and well-being.¹⁹

EEG measurements are used artistically and scientifically to translate brain waves directly into organized sound using algorithms. Composers and scientists alike use the EEG signals to create musical sounds. An interesting aspect of "sonification," is that conscious and creative manipulation of brain waves (neurofeedback) becomes a plausible and manageable feat.²⁰ In essence, it is a form of meditation with potential to provide musical compositions

¹⁷ Neuhaus, 359.

¹⁸ Neuhaus, 358-360.

¹⁹ Neuhaus, 361.

²⁰ Bart Lutters, Peter J. Koehler, "Brainwaves in Concert: The 20th century Sonification of the Electroencephalogram," *Brain: A Journal of Neurology*, 139 (August, 2016): 2408-2814, doi:10.1093/brain/aww207.

determined by the composer's mental state and brain waves. It also redefines the role of the composer, as this skill is irrespective of talent and musical training. Although based upon a subjective algorithm, modulating or amplifying brain waves to facilitate changes in the music and creative direction highlights a connection between thought, our perception of sound, and the physical properties of sound. This avenue for creating music that reflects an individual's mental state or well-being can be used as a therapeutic tool to entrain that mental state or well-being onto others. This is an example of modern neuroscience providing innovative and valuable tools for modern musicians.

The effects of sound and music upon the nervous system is often amplified in the absence of other senses such as sight. Examining the effects of sound in the absence of other senses will provide further insight. Blind persons and musicians are often gifted with an extraordinary sense of hearing or touch, or an ability to use frequencies and sounds to map their surroundings.²¹ Neuroplasticity allows for recruitment of unused portions of the brain, and the activation of the visual cortex in blind people as they listen to music is evidence of this recruitment.²² Could we tap into this extrasensory capacity ourselves as performers and audience members? By depriving ourselves of one or more senses in order to respond more profoundly to sound, we may have an avenue to identify the effects of sound on our physical and emotional bodies. After all, music is a sound art, which as a listener does not require participation of the other senses.

²¹ Lore Thaler and Melvyn A. Goodale, "Echolocation in Humans: An Overview," *WIREs Cognitive Science*, 7 (August, 2016): 382-393, <https://doi.org/10.1002/wcs.1408>.

²² Elena Mannes, *The Power of Music: Pioneering Discoveries in the New Science of Song* (New York, NY: Bloomsbury, 2011), 75.

Music as Therapy

Although using music as a therapeutic tool has been a cultural tradition for centuries around the world, music therapy in the western world emerged as a credible approach to psychotherapy in the mid-20th century when the American Music Therapy Association was created.²³ There are an *enormous* number of variables when using music as therapy, including the subjective taste of the listener, the type of music used, and the desired effect. The desired effect can possibly range from physical to mental, emotional, social, behavioral, or educational, depending on the application. Controlling these variables and accurately measuring music's effects becomes a major obstacle when quantifying the benefits of music therapy.²⁴

Determining what the *cause and effects* of music are on the human brain is a fundamental challenge for scientists. This is because the way in which individuals experience the world differs from person to person, and each observer to a phenomenon experiences it differently.²⁵

Scientists in the early 20th century concluded that there is an innate physical element to sound which can influence our nervous system and physical bodies. This human "tendency to vibrate synchronously with music" was proven by the response of deaf mutes to musical sounds and their ability to "distinguish several different instruments based upon the nature of the vibrations."²⁶ In another example, the infectious nature of powerful rhythms creates a tension in the body which can only be satisfied through movement or dance. In the latter half of the 20th century, the American film and advertisement industry, aided by scientific studies such as

²³ Cowan, 130.

²⁴ Emil A. Gutheil, *Music and Your Emotions* (New York: Liveright, 1952), 10-11.

²⁵ Gutheil, 17.

²⁶ Gutheil, 30.

the Carpurso study as well as innovations in electroacoustic music, discovered the general patterns of musical/emotional associations that could be applied to influencing large audiences in a predictable way.²⁷ This study cross-referenced the reactions of listeners to reinforce the notion of stereotypical musical sounds that are recognizable to most individuals. In this era, the Muzak corporation developed mood music, which was “to be heard, not listened to.” Mood music was created with the purpose of subconsciously influencing the listeners in retail and public spaces.²⁸

It is interesting to note that the elements of music that produce noticeable psychological responses, such as tempo, pitch, rhythm, harmony, and volume are rivalled by a contrasting lack of sound – silence.²⁹ The power of anticipation and expectation when it comes to silence in music is a unique aspect of rhythm. It could be hypothesised this indicates the listener’s potential to be mechanically resonating with the music or sound; internal processes such as heart beat or brain waves could vibrate synchronously with rhythmic patterns. Rhythm is based upon time, which is a primary factor in determining vibration frequency. Vibrations and waves associated with the functions of the human body are well-observed phenomenon. Anatomical resonance to sound vibration will be explored later.

Consciously mediating the activation of one’s own sympathetic nervous system can be practiced and mastered through various means, including meditation and exposure therapy. There are some individuals who may have experienced trauma that interferes with their ability to mediate a fight-or-flight response, or who may have a mental health condition that inhibits

²⁷ Gutheil, 59.

²⁸ Cowan, 133.

²⁹ Cowan, 133.

their ability to control their response. Many of these individuals with PTSD are triggered through aural stimuli, indicating that sound has enormous potential in shaping perceptions of memory.

In modern case studies of music therapy, vibroacoustic therapy shows promising results in improving muscle-tone and range of motion in patients. This therapy usually combines relaxing, 'sedative' music with a low frequency pulsed tone around 44 Hz.³⁰ The results of the experimental therapies shows the ability of these vibrations and frequencies to interact with the muscles themselves rather than purely activating a psychological channel that leads to muscle development or relaxation. Additionally, the peripheral nervous system may actually be activated as well by these vibrations. Concluding from a series of case studies, Tony Wigram found that vibroacoustic therapy alleviates many symptoms of physical and psychological disorders.³¹ This further supports the case that the vibrational aspect of sound is fundamental to our perception of music as well as its harmonic and rhythmic organization.

Anatomy

To better understand how sound is perceived, it is necessary to briefly examine the anatomy of the ear. The function of the ear is to “transduce sound impulses into electrical impulses” to the brain, while the mental activity of processing these electrical impulses is what is referred to as hearing.³² But is this the only way in which these sound frequencies interact

³⁰ Tony Wigram “Music and Sound Vibration: Testing Hypotheses as a Series of Case Studies” in *Case Study Designs in Music Therapy*, ed. David Aldridge (London, UK: Jessica Kingsley Publishers, 2005), 168-170.

³¹ Wigram, 189.

³² Eric J. Heller, *Why You Hear What You Hear: An Experimental Approach to Sound, Music, and Psychoacoustics* (Princeton, NJ: Princeton University Press, 2013), 415.

with human physiology? The eardrum sympathetically resonates with the mechanical vibrations of sound to produce electrical signals, so it is possible other parts of our anatomy are harmonically resonant and responsive to sound.

Mechanical resonance of the ear was first explained by Hermann von Helmholtz in the 19th century by raising the damper pedal of the pianoforte and singing into the instrument. The resonance of the many strings sympathetically vibrating creates much more volume than a single raised damper on one note.³³ As is seen from the structure of the inner ear, the concept of resonance becomes of primary importance. The vibrations of sound are transmitted through the tympanic membrane to the inner ear where the hair cells of the cochlea detect specific frequencies and transmit those frequencies into electrical signals to the cochlear nerve.³⁴ Although these hair cells are suspended in fluid and therefore dampened in their ability to sympathetically vibrate and resonate with incoming frequencies (mechanical resonance), the detection of specific frequencies by specific hair cells is evidenced when damage occurs to these structures. Extended exposure to frequencies at high volumes can damage the specific receptors of that frequency, leading to permanent loss of hearing of those frequencies. Furthermore, the basilar membrane, which resonates with sound stimuli, is “tuned along its length like the musical scale: frequency is scaled up exponentially progressing up the membrane.”³⁵

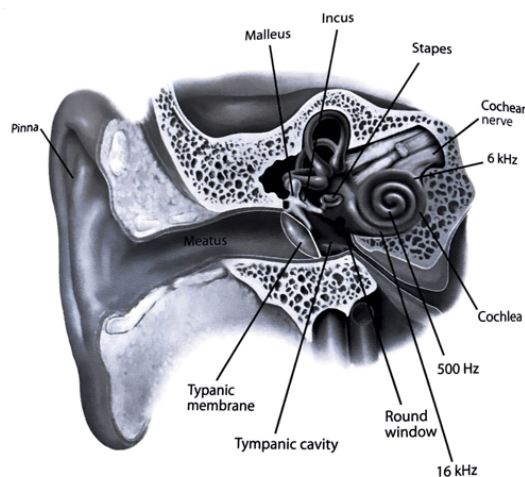
Despite all these mechanically resonating structures of the ear, the sense of hearing is nonetheless the brain’s interpretation of electrical signals transduced from sound stimuli. As

³³ Heller, 428.

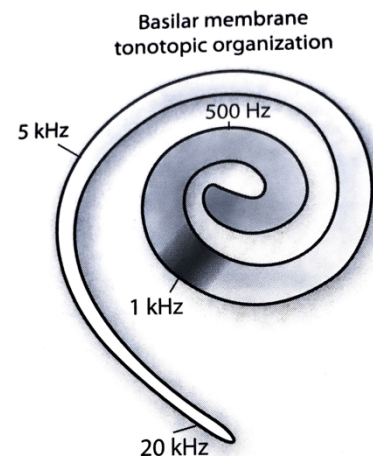
³⁴ Heller, 417.

³⁵ Heller, 423.

mentioned earlier, the response of deaf-mute individuals to music supports the idea of mechanical resonance within other structures of the body. Advances in technology have exploited *bone conduction* in innovative headphones that transduce sound waves to cranial bones. *Bone conduction* is how sound is transmitted to the inner ear through the bones of the cranium rather than through the air in the ear canal.³⁶ Therefore, since sound waves travel through air and bone, there is further evidence that rhythm and frequency physically interact with our anatomy, resonating with our own internal rhythms and frequencies to compel movement and dance.



Cross-Section Human hearing apparatus³⁷



Basilar Membrane tuning³⁸

³⁶ *The American Heritage Dictionary of Medicine*, s.v. “Bone conduction,” Accessed January 12, 2020, https://search-credoreference-com.du.idm.oclc.org/content/entry/hmmedicaldict/bone_conduction/0

³⁷ Heller, 416.

³⁸ Heller, 423.

Quantum Physics

“If you wish to find the secrets of the universe, think in terms of energy, frequency, and vibration.” – Nikola Tesla³⁹

The intersection of quantum physics and music offers some clues as to how the vibrations of musical and human frequencies are deeply intertwined. The hypothesis that the state of matter is paradoxically both wave and particle at the same time means even the matter within our bodies has a vibration frequency.⁴⁰ String theory, while inferring the existence of vibrating filaments within all matter, seeks to organize the universe based upon vibration.⁴¹ The measurable vibrations of objects in the universe, the “music of the spheres” as the Greeks postulated, produce actual sound waves with extreme frequencies far beyond human hearing capacity (57 octaves below middle C).⁴² The inclusion of classical thought within these modern scientific theories are expanding our understanding of existence as purely material, to deeper energetic and spiritual levels. The classical idea that music can influence body, mind and spirit (humoral medicine) can now be studied with scientific methods and applied using principles of music therapy and quantum physics.⁴³

³⁹ Robert I. Sutherland-Cohen, *Tesla for Beginners*, (Danbury, CT: For Beginner Books, LLC, 2016), 61.

⁴⁰ *Encyclopaedia Britannica*, s.v. “Wave-particle duality,” Accessed March 28, 2020, <https://www.britannica.com/science/wave-particle-duality>

⁴¹ Elena Mannes, *The Power of Music: Pioneering Discoveries in the New Science of Song* (New York, NY: Bloomsbury, 2011), 146-160.

⁴² A. Fabian et al, “A Deep Chandra Observation of the Perseus Cluster: Shocks and Ripples,” *Monthly Notices of the Royal Astronomical Society* (2003), quoted in Elena Mannes, *The Power of Music: Pioneering Discoveries in the New Science of Song* (New York, NY: Bloomsbury, 2011), 159.

⁴³ Tony Wigram, Inge Nygaard Pederson, and Lars Ole Bonde, *A Comprehensive Guide to Music Therapy: Theory, Clinical Practice, Research and Training* (London, UK: Jessica Kingsley Publishers, 2002), 28-29.

Quantum and metaphysics allows us to frame a lot of 'spiritual' questions in a scientific framework. Ideas such as non-local entanglement and metaphysical connection have explained the profound energy connections between individuals that can be shared across time and space. For example, individuals who meditate together or share a mental connection show a distinct, measurable connection, or 'entanglement', after they are separated.⁴⁴ This mental connection could be a useful tool in performance and teaching as it allows us to share music with a sense of community and camaraderie and removes barriers between performer, audience, and the music.

Ancient Wisdom

As our understanding of the physics of sound grows, as well as that of our own anatomy, physiology, and psychology, researchers can look back to ancient traditions and integrate the intuitive knowledge of philosophers, sages and mystics with the science of the 21st century.

In Classical Greece, humoral medicine was studied and practiced alongside the principles of the great mathematician Pythagoras. The harmonic balance of the four 'humours' was the key to good health, and music was considered a tool for restoring this balance in poor health. These ideas were considered foundational aspects of European medicine up until the 18th century and intersected with musical treatises of the times, often connecting the humours with celestial bodies, temperaments, and music.⁴⁵ Agrippa Von Nettesheim, in the early 16th

⁴⁴ Rich Haas, *Sacred Quantum Metaphysics: Easy-to-understand Scientific Shortcuts to Ancient Wisdom*, (Madison, VA: Christine F. Anderson Publishing and Media, 2016): 178.

⁴⁵ Wigram, Pederson, Bonde, 25.

century, speculated about the relationships between reality, man, and music by describing them as follows:

- The physical world-the human body-the vibrations of music
- The world of language-the human mind-the notes and intervals of music
- The cosmos-the human spirit-the divine proportions of music⁴⁶

To summarize, the physical, mental, and emotional aspects of music are directly connected with the order of the universe and resonate with the corresponding experiences of each state of being. The first bullet point speaks to the way rhythmic patterns compel the physical body to movement. The second reflects modern understandings of the psychological effects of music being based upon the quality of the music itself, rather than specific vibrational characteristics of the sound. The last bullet correlates with the almost inexplicable preference for order and form over disorder and chaos.

The classical ideas from Plato and Pythagoras of the natural order of the universe implied that music existed in the cosmos independent of man and was harmonious in its reflection of the perfect relationships of the cosmos. They believed the reason music sounded harmonious to humans was a consequence of its relationship to their internal, biological rhythms.⁴⁷ In other words, the physical body resonates with the non-physical universe.

The use of music as 'spiritual medicine' among various cultures across the globe dates back thousands of years, from Ancient Greece, to the Middle East, to indigenous American cultures. Music is used in ritual and ceremony to balance or relax the mind, perhaps even

⁴⁶ Wigram, Pederson, Bonde, 25.

⁴⁷ Jamie, James *The Music of the Spheres: Music, Science, and the Natural Order of the Universe* (New York: Copernicus, 1995), 65.

entering a trance state where brain waves associated with deep sleep and relaxation are elevated. Focusing on a rhythmic stimulus for extended periods facilitates entering altered states of consciousness in which a new level of self-awareness may be attained.⁴⁸ These sorts of shamanic rituals were used to heal the spiritual body as well as the physical body because they were believed to be intrinsically connected. Diseases of the body were often attributed to spiritual affliction since the spirit world and the real world existed side by side, connected and influenced by one another. These ancient cultural traditions often combined music and sound therapy with herbal medicine, modern medicine, or plant-based hallucinogens to holistically treat illness.⁴⁹ Many of these traditions produce similar effects to modern electronic and electroacoustic music, which expedite entering altered states of consciousness.

The traditions of Yoga and meditation have also relied on sound and music to achieve altered states. The philosophy of yoga concludes that the universe is in a state of vibration, which is supported by modern knowledge of physics and the cosmos. Hindu sages believe the vibrations of the universe create an audible stream of sound, or *shabda*, similar to the music of the spheres.⁵⁰ Since sound and music are also a form of vibration, they are popularly used in rituals such as Mantra yoga. Through the use of repetitive sound, namely chanting or singing, states of consciousness can be expanded.⁵¹ The ‘mantra’ consists of a “sacred utterance, numinous sound, or sound that is charged with psycho-spiritual power.”⁵² Recent studies to the

⁴⁸ Yehuda, 88.

⁴⁹ Johnathan Weinel, *Inner Sound: Altered States of Consciousness in Electronic and Audio-Visual Media* (New York: Oxford University Press, 2018), 32-33.

⁵⁰ Elena Mannes, *The Power of Music: Pioneering Discoveries in the New Science of Song* (New York, NY: Bloomsbury, 2011), 145.

⁵¹ George Feuerstein, *The Yoga Tradition: It's History, Literature, Philosophy, and Practice* (Arizona: Hohm Press, 1998), 51.

⁵² Feuerstein, 51.

efficacy of mantra or ‘transcendental’ meditation shows a great deal of promise for individuals with PTSD.⁵³ The soothing effect of repetitive positive reinforcement through mantra positively affects self-image and perception. The skill of mediating the response and excitation of the nervous system is developed through these practices as well.

Yoga-Nidra, or yogic sleep, uses relaxation techniques to enter altered states of consciousness that correspond with the four aforementioned types of measurable brain waves.⁵⁴ The conscious manipulation of brain activity to enhance specific frequencies of brain waves, and therefore mental states, can provide intriguing strategies for musicians in practice and performance. Since music has a measurable impact upon brainwaves, these states of consciousness that correspond with each frequency can change the way we experience music both as performers and audience members. Proactively applying relaxation and meditation techniques as an individual or with ensemble members, or alternatively with audience members, will prime the brain for the most therapeutic effects of music. Musicians may also engage in these exercises in the practice room before each session to prime the brain for processing new information and insulating existing neurologic pathways.

In the yoga tradition, the ‘subtle body’ refers to the organs of the psychospiritual body, the energies underlying the organs of the physical body. The notion of *chakras* and *nadis*, energy centers and pathways throughout the body which vibrate at specific frequencies, is one yogic explanation of the human spirit.⁵⁵ These energy centers are as important to our well-

⁵³ Divya Krishnakumar, Michael R. Hamblin, and Shanmugamurthy Lakshmanan, “Meditation and Yoga can Modulate Brain Mechanisms that Affect Behavior and Anxiety: A Modern Scientific Perspective,” *Anc Sci 2*, no. 1 (April 2015): 13-19.

⁵⁴ Kamakhya Kumar, “A Study on the Impact on Stress and Anxiety Through *Yoga Nidra*,” in *Indian Journal of Traditional Knowledge 7*, no.3 (July, 2008): 401

⁵⁵ Feuerstein, 350.

being as the health of our physical bodies, and thus there is a need to maintain harmonious balance among those vibrations. Rituals for balancing these vibrating centers often rely on sound, with specific frequencies assigned to each *chakra*.

The Tibetan Singing bowl, another ancient medicinal tool, is a harmonically resonant metal bowl that is struck or ‘stirred’ to create a vibration/tone that will interact with the energies of the subtle body. Mirroring the results of vibroacoustic music therapy, Tibetan singing bowls have been shown to interact with humans on a psychological level. The physical level in which the sound and vibrations can impact the human body is not fully studied, yet for those who have experienced sound bowl meditation or therapy, there are clear physical sensations arising from the vibrations. Participants in a study of the efficacy of Tibetan singing bowl meditation reported large decreases in tension as well as decreases in physical pain.⁵⁶ Determining if the sound vibration was physically interacting with the physical body or simply initiating psychological changes that led to changes in physical sensation, bears further study.

Applying What We’ve Learned

After reviewing music therapy trends and strategies, as well as historical contexts of music being used as therapy and medicine, it is clear that there is a need for finding new ways to apply these principles in general practice and performance situations. Music therapy is often used as a form of individual psychotherapy, but the potential of music to reach many at once gives musicians the unique opportunity to impact and heal those in their communities. These

⁵⁶ Tamara L. Goldsby, Michael E. Goldsby, Mary McWalters, and Paul J. Mills, “Effects of Singing Bowl Meditation on Mood, Tension, and Well-Being: An Observational Study,” in *Journal of Evidence-Based Complementary and Alternative Medicine*, 22, no.3 (August, 2016): 401-405

therapeutic qualities provide a distinct advantage for musicians at any point during practice, teaching, or performance to not only increase efficiency but also proactively manage mental health and well-being.

A routine for music practice that integrates wellness practices at regular intervals or during practice breaks and also includes mindful self-analysis to inhibit habitual patterns of response to tension and technical difficulties, will reinvigorate the learning process and can reinvigorate passion for practice and for music. Wellness practices that incorporate music, sound and vibration are vital to musicians and non-musicians alike, and already blur the conventional lines of applied music therapy.

Using sensory deprivation in the practice room is another possible avenue of exploring different performance modalities. This shifts mental focus to rely on vibrational feedback rather than aural feedback or, to rely on tactile feedback and spatial awareness instead of visual cues. It is also possible to eliminate both visual and aural feedback to more exclusively focus on tactile feedback. An example of an exercise for sensory deprivation requires using noise-cancelling headphones while recording ones performance, therefore relying on tactile and vibrational feedback as well as the ability to internally audiate the music. Practicing in a dark room or with a blindfold removes visual cues and can enhance tactile feedback as well as listening skills. Combining both strategies would focus all nervous feedback on the tactile senses, therefore strengthening those pathways and allowing the brain the opportunity to focus on the unrelated senses of taste and smell. Although taste and smell are unrelated to the music, integrating all sensory feedback into the experience is a mindfulness strategy for reducing distracting thoughts and stress.

One of classical music's most prolific and adored composers was involuntarily deprived of one of his senses, yet he composed some of his most profound and meaningful repertoire after losing his hearing. Beethoven's plight may have provided him a window into the vibrational dimensions of the universe and allowed him to explore his art through that lens. Applying this lens to practice may provide valuable insight for musicians, teachers, and artists.

As teachers and performers, reaching our students and audiences through techniques designed to heighten awareness and reduce stress and anxiety can significantly impact their experience. Teachers should create an understanding in their students that the practice room is a positive and healing space and frequently bring awareness back to the therapeutic qualities of music. The high-stress performance scenario produces fear and anxiety not only in the performer, but also in sympathetic audience members, and creates a sense of urgency that can potentially distract from the reception of the music and all the therapeutic qualities it can provide. If audiences prepared for performances in similar ways that the actual performers prepare to deal with stage fright and nerves, the experience of the performance could be profoundly heightened. Audience participation in this activity, perhaps even done with or guided by the performer himself, works towards unifying and heightening the experience for all in the room. It can create a sense of community that removes the gravity and solemnity that clouds the air of a musical performance. In the act of intentionally preparing the mind to be receptive, mental distractions are minimized, clearing the way for music to heal and inspire. This heightened experience certainly facilitates the ability of music to calm and excite the mind and nervous system.

Considering the polarity of psychological and physiological effects of music, concert programming and repertoire choices for students can be thoughtfully informed by the knowledge gained from modern science and ancient wisdom. Understanding just how sound interacts with the nervous system, which pieces or movements will be calming and which will be excitatory, helps inform decisions about how to create concert programs. There are numerous considerations and variables that influence these decisions including the target audience, the desired effect, the overall theme or scheme of the program, as well as the capabilities and strengths of the performer. A performer has the option to sequence pieces in a way that slowly builds up in activation of the nervous system or tapers in activation at the end of the concert, depending on the goals of performance.

Music is a sound art and thus encourages us to attend more closely to our sense of hearing in order to communicate effectively. When we deprive ourselves of some senses, others are heightened simply by reducing stimulus input to the brain. The interconnectedness of sensory brain areas allows recruitment of inactive areas for the primary sense in use. Using this principle in performance and practice, a musician could remove sight as an aid to playing their instrument and an audience member could close their eyes to heighten their aural experience. Perhaps the lights could be dimmed during a performance to both remove the spotlight on the performer and allow the audience an opportunity to become more introspective through focused sensory input.

As research in the fields of music, psychology, and modern science continues to emerge, we will soon have a more quantifiable understanding of the immense power of music and sound. Studying the effects of sound on our nervous system is a challenge many scientists are

currently engaged in, working to understand the metaphysical principles of music and sound.

These modern sciences will continue to expand our knowledge of ourselves, of the cosmos and the non-physical universe, and the way energy travels in the universe and through our bodies.

Through this knowledge we will begin to fully understand the magic that is music and how best to use it for the good of humanity. Through music, all people can achieve a *sound* mind.

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