THE NEUROSCIENCE OF MUSIC: AN INTERDISCIPLINARY STUDY OF THE EFFECTS OF MUSIC ON THE BRAIN

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Abstract

The human brain has evolved into a system which can analyze sound and assign meaningful associations to that stimulus. Studying the human brain with respect to music leads us to ask, why people make music, how people perceive the music and how does music influence the human body? Dancing, playing music, listening to music, and singing all have affective responses. Humans can use their body to move to music or can use their body to produce music. Dance as an “orchestration of energy” is a very deep biochemical experience which produces a rush of neurotransmitters in the brain thereby inducing many different sensations and emotions. Singing and the emotional impact of sound affects the body through the vagus nerve, which passes through the ear, extends into the larynx and all the internal organs including the entire intestinal tract, back muscles, lungs and heart. It carries the fibers that control the release of gastric and pancreatic secretions, and inhibitory fibers of the heart.

This dissertation considers the healing properties of music. It studies the insula, a very unified center of the brain that connects different functional systems such as sensory, emotional, and cognitive processing and is also responsible for processing both positive, negative, and socially appropriate emotions. The results of two quantitative pilot studies through brain imaging scans on the healing effects of music and dance on Parkinson’s disease are introduced. Statistical data presented without assessing the emotions of the participants who undergo the difficult process of sickness and aging is rigid science which lacks the information on the hidden, vulnerable sides of human beings. Since music and dance deal with the psyche and the body together, a conversation with one of the participants is added to understand the feelings regarding the inability of science alone in dealing with an incurable disease and the hope that music brings for a better quality of life.

Dedication

With love and admiration, I dedicate this PhD dissertation to all the women who have sacrificed their desire for higher education to prioritize their families. I hope that this work can serve a reminder that it’s never too late to pursue your passion. You have the power to make a difference, and your pursuit of your education is a testament to your strength and perseverance. I hope that this dissertation inspires you and others to continue to strive towards your goals, regardless of your age or circumstances.

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Acronyms Chapter 2

ACC	Anterior Cingulate Gyrus
AI	Anterior Insula
BG	Basal Ganglia
CNS	Central Nervous System
dAI	Dorsal Anterior Insula
DLPFC	Dorso-Lateral Pre-Frontal Cortex
DTI	Diffusion Tensor Imaging
ECG	Electrocardiogram
EEG	Electro Encephalography
fMRI	Functional Magnetic Resonance Imaging
HR	Heart Rate
iEEG	Intracranial Electro Encephalography
IFC	Interior Frontal Gyrus
MCC	Mid Cingulate Cortex
NAc	Nucleus Accumbens
OFG	Occipital Frontal Gyrus
PCC	Posterior Cingulate Cortex
PD	Parkinson’s Disease
PI	Posterior Insula
ROI	Region of Interest
rsEEG	Resting State Electro encephalography
SFG	Superior Frontal Gyrus
SMA	Sensory Motor Area
SNc	Substantia Nigra Pars Compacta
STG	Superior Temporal Gyrus
S1	Primary Somatosensory Cortex
S2	Secondary Somatosensory Cortex
vAI	Ventral Anterior Insula
VEN	Von Economo Neurons
VTA	Ventral Tegmental Area

Glossary Chapter 4

- Aura: The electromagnetic field around each living being's body.
- Ayurveda: The traditional Hindu medical system considered as a part of Yoga philosophy.
- Bija mantra: One syllable sound used for balancing the chakras in the body.
- Cortical charge: The brain's electrical stimuli to be considered conscious. The brain needs three billion stimuli per second for at least four and a half hours a day in order to maintain consciousness.
- Medulla oblongata: The lowest part of the brain attached to the spinal cord responsible for most of the involuntary jobs in the body such as regulating the blood pressure and breathing.
- Morphogenetic field: Based on the idea that a group of cells are able to respond to discrete, localized biochemical signals, scientists argue that this field helps guide the formation of later similar system by tuning into a previous system. This idea derives from the theory that there is a memory in nature and it's due to morphic resonance.
- Mudra: A specific hand or fingers or body gesture used in breathing techniques of Yoga practices for guiding the Prana or Life Force to different parts of the body. It works like an electrical circuit for stimulating different body parts.
- Seed mantra: Same as Bija mantra.
- Stapedius muscle: A muscle that regulates the stapes, one of the three tiny bones of the middle ear.
- Tetragrammaton: The Hebrew name of God transliterated in four letters as YHWH.

- Vedic astrology: Indian astrology reading the effect of the planets on every individual. Based on the exact date, time, and place where each person was born.
- Vestibular labyrinth: Central cavity of the labyrinth that makes up the inner ear.

Introduction

At the dawn of the twenty-first century human beings, with the help of technology, have dramatically increased the number of new discoveries. Plans have been created to support the idea of people living on other planets. Despite all these improvements, the human brain is still full of mystery and unknown capacity. To understand the function of the brain researchers need to observe the organ while it is alive and working. But how can we delve inside and non-invasively study the function and workings of the brain? Brain research has become possible only by sacrificing animals or through the volunteering of individuals with brain issues. Studying the normal brain is very difficult and, while many of the functional regions of the brain have been discovered, the networks related to behavior and emotions remain a mystery. One of the first recorded cases involved King Henry II of France in 1599. The king fell from his horse while jousting, and was hit by a wood splinter from his opponent's lance. (Probably his gold-plated visor was not properly in place.) Physicians assumed little damage beyond the right eye, but the king died a month later due to intra-cranial hemorrhage. Autopsy, not then permitted except for suspicion of death by poisoning, was performed with the permission Queen Catherine, by two palace surgeons. History is forever grateful to her. The physicians were led to understand the concept of brain trauma without any skull fracture (Kean 2014). After Henry's death, autopsies became more common in Europe which enabled physicians in understanding symptoms related to brain damage and altered behaviors.

In the mid-nineteenth century physiological explanations of human behavior emerged distant from philosophical descriptions. Psychologists started to merge with biologists and decided to study the brain in the laboratories instead of cafés. For this to be possible, especially in the American schools, separation of the concept of the mind from the brain and also the by-

products of the brain such as emotions and behavior was accepted. By the 1990s with the invention of neuroimaging machines such as fMRI, PET, and MEG, the brain could be studied in real time while an individual was experiencing an emotion or presenting a behavior. Music is a sound creation that conveys emotions and, since it has been with humanity for many centuries, it deserves to be a point of interest in scientific research.

Research shows that development of muscles in Homo sapiens resulted in the ability to sing and this ability preceded the ability to speak (Montagu 2017). The ability to hum and produce melodic sounds never needed proper anatomical and physiological developments and we should separate this kind of music with "music proper" which needs the control and understanding of pitch. Music has been with human beings from very early stages and dance has not been separated from it. Even birds flap rhythmically for certain purposes such as mating, and animals, such as gorillas, drum their chests and move rhythmically (Geissman 2000). We can never know whether rhythmic moves led to music accompaniment or music led to rhythmic movements. The oldest musical instrument known today, believed to be circa 60,000 years old, was found in the Divje Babe cave in Slovenia. It is a bone with two holes which can produce certain pitches. There has been a lot of debate on the application of this bone and the latest is by Turk (2014) who maintained that these holes were created by humans. Thus, the question is reinforced – what is the point of music and its development in human's evolution?

Besides entertainment, there are applications of music for healing such as dance, ritual, and toning and these concepts are investigated in this dissertation.

Humans have five portals for data intake and these portals correspond to the outer world. Among these five, the ears are always open and sound input is more difficult to be voluntarily averted. One of the differences between the brain of Homo sapiens and the apes is the extensive

development in the areas related to processing the auditory information. Increase in the size of the temporal lobe related to auditory reception of speech area in dorsal region is quite exceptional in humans in comparison with other animals (Trimbler 2017).

> The expansion of primary and association auditory cortices and their connections, associated with the increased size of the cerebellum and areas of prefrontal and premotor cortex linked through basal ganglia structures, heralded a shift to an aesthetics based on sound, and to abilities to entrain to external rhythmic inputs (Trimbler 2017, 29).

The human brain has evolved into a system that can analyze sound for meaning. Music perception seems to be unique to humans since studies on animals indicate no clear preferences between music and other sounds (Kolb et al., 2016). Studying the brain with respect to music generates various questions. Why do people make music? How do people perceive music? How does music, when combined with physical movement and dance, influence the human body and mind? Dancing, playing music, and listening to music all generate affective responses. Music has always been present in all aspects of human culture. Its purpose has served a large spectrum from entertainment to healing. Nietzsche, the great German philosopher, musician, and poet of the nineteenth century stated, “without music, life would be a mistake” (Nietzsche 1889). Many people have been curious to understand why music can have different impressions on people. Scientists today know that a large network in the cortical loops between auditory and frontal cortices (bilateral medial frontal gyrus and motor cortex) and subcortical region (mesolimbic striatal system responsible for pleasure and reward), are engaged while listening to or making music (Zatorre et al. 2013; Koelsche 2014; Gordon et al. 2018; Freitas et al. 2018). However, research on brain structure has yet to reveal which regions are ultimately connected to music processing. *Amusia* (the inability to perceive pitch in music) or acquired amusia (the impairment in music production with a neurological basis), have given researchers the opportunity to find out

more about the critical parts involved in the musical brain (Price et al. 2002; Rorden et al. 2004). In the latter twentieth century, the invention of brain imaging technology (such as fMRI, etc.) moved neuroscience research to a much richer level.

At the dawn of the new century, with rapid and revolutionary progress in technology, the subject of neuroscience has achieved prominence. Some thinkers, such as Jonah Lehrer, have concluded that everything cannot be known and those "unexplainable" things can be considered "art" (Lehrer 2009). This idea has engendered a new field referred to as *neuroaesthetics*. "Neuroaesthetics is the study of the neural basis for the contemplation and creation of a work of art" (Nalbantian 2008). This emerging field of neuroscience studies the reasons why humans make art such as music and why they enjoy it.

This study can serve a reference point for researchers interested in the effects of music on the brain and its different applied versions and, may be considered a synthesis of research which can be used towards future research on the effects of music on the brain as a complementary tool in healing diseases. Disease means not being in ease. This can be in the level of micro-organisms to macro-organs in the body or in a subtler level of the mental state. Quantum mechanics states that our universe is nothing but a vibrating string of energy (Cremonini 2017). (https://www2.lehigh.edu/news/the-vibrating-essence-of-the-universe). Everything is vibrating and our ears can only hear a specific range of this vibration often stated as lying somewhere between 20 – 20K Hertz. "Life is the innumerable vibrations of every single atom in our body thus, we can state that human beings are music that have manifested into a solid form". (http://www.esalq.usp.br/lepse/imgs/conteudo_thumb/Everything-in-life-is-Vibration.pdf). By

studying the effects of music on the brain, the organ in charge of our thoughts and actions, we can help this musical “solid form” to dance with ease.

Humans gather to sing songs or play music and dance at a wide variety of events. There are two main branches for studying the cognitive neuroscience of music, 1) music with respect to emotions which leads to neuroaesthetics, and 2) the perception of the musical structure which constitutes a more cognitive approach. Different brain areas are involved in music production and music perception. These regions were first discovered by studying Maurice Ravel (1875-1937) who had experienced a left-hemispheric stroke. Ravel’s music perception abilities remained intact, however, he could no longer compose and he lost the ability to play the piano (Kolb et al. 2016). Results of this study suggest that the left hemisphere is dominant in making music and the right hemisphere is more dominant in perceiving music (Kolb et al. 2016). It is notable that music perception is often accompanied by an emotional response and many parts of the brain are associated with emotions.

The human race requires the ability of attention, introspection, time perception, and perceptual decision making to survive, and these qualities make scientists interested in the study of the different parts of the brain which are activated, in all these instances, by music.

This dissertation investigates the healing properties of music and dance on Parkinson's disease by examining the relationship between music and the human brain, particularly the insula, a unified center of the brain responsible for processing sensory, emotional, and cognitive information. The study also highlights the emotional impact of music on participants and their feelings regarding the inability of science to cure the disease, emphasizing the importance of a holistic approach to healthcare that integrates both the physical and psychological well-being.

Chapter 1: What is music?

It is very challenging to explain music in words. Victor Hugo once said, “music expresses that which cannot be put into words, and which cannot remain silent” (Hugo 1864).
As Darwin mentions, “Musical ability of the humans is amongst the most mysterious with which he is endowed” (Darwin 1871). Music is ubiquitous among humans without having any obvious use although we can easily describe our “feelings” while we listen to music. In a crude way, music is organized sounds made of different pitches that create feelings, but it has different meanings and results for different people. It’s all about perception which connects art to neuroscience. Sound waves are made of the movement of air molecules which do not have any pitch or frequency by themselves. Their oscillations are measured by the human brain which creates the perception of a sound or a pitch. Musical pitch exists in the mind, not in the outer world (Levitin 2007).

Music should be separated from speech and animals’ sounds. Bruno Nettl, a renowned ethnomusicologist explains music as “human sound communication outside the scope of language” (Nettl 1983, 24). It is true that music is made of sound, but silence is an essential element of it to make the sound meaningful, and by meaningful, I mean creating emotions. Emotions can be either pleasant or unpleasant (Montagu 2017). To differentiate this description from speech, music needs to have several other elements. The seven major elements commonly employed to define or analyze music are: pitch, rhythm, melody, harmony, timbre, texture, and form.

> “Pitch is the location of a sound in the scale depending on the speed of vibrations from the source of the sound, fast ones producing the high pitch and slow ones a low”

(Kennedy et al. 2013). Pitch as mentioned is a psychological set up (Levitin 2007). It is the perception of the frequency of sound by human's ear.

- Rhythm is the length or duration of series of notes expressed across time. "Covers everything pertaining to the time aspect of music" (Kennedy et al. 2013). Rhythm exists or can be heard at different paces which is called tempo.
- Melody is the main theme of a song. "A succession of notes, varying in pitch, which have an organized and recognizable shape. Melody is 'horizontal', i.e. the notes are heard consecutively" (Kennedy et al. 2013).
- Harmony is a backup for the melody and can be either a parallel melody or chord progressions based on the genre of the music. It is based on the pitches and tonal context of the setup of the pitches for making the next phrase of the song to be either predictable or unpredictable. "The simultaneous sounding (i.e., combination) of notes, giving what is known as vertical mus., contrasted with horizontal mus. (counterpoint)" (Kennedy et al. 2013).
- Timbre is the color of the sound. It is the element of the sound which makes our ears differentiate between for example a wind instrument and a keyboard. Based on the *Grove Dictionary of Musical Instruments*, "Timbre is the quality that allows a listener to identify an instrument or a particular voice by its sound; the American National Standards Institute (ANSI S1.1–1994 (R1999) defines timbre as 'that attribute of auditory sensation in terms of which a listener can judge that two sounds, similarly presented and having the same loudness and pitch, are dissimilar" (Kennedy et al. 2013).
- "Texture describes the vertical build of the music—the relationship between its simultaneously sounding parts—over a short period of time. If each of the combined

parts is shown to have a more or less continuous linear character, all being of equal importance as horizontal lines, then the music is said to exhibit a contrapuntal texture" (Latham 2011). Texture is the combination of the melodic, harmonic, and rhythmic components of a piece of music which can be established by one or a few layers. Different textures of a song are monophonic (one melodic line with no harmony or accompaniment), homophonic (with one clear melody line and the rest of the sounds provide accompaniment), polyphonic (with more than one melody at the same time) and heterophonic which is mostly heard in South Asian, middle Eastern and Indigenous music (with one melody and different variations of it sung or played at the same time).

- Form is the total structure of a musical composition, and it is built upon phrases or passages. These phrases can expand and develop throughout the song. They can combine into larger components which can be repeated or reverted. If we can identify different sections in the song, the form is sectional and if one phrase or passage repeats throughout the song it is called strophic form. Based on *Oxford Companion to Music*, "Form can be said to be the way in which the various elements in a piece of music—its pitches, rhythms, dynamics, timbres—are organized in order to make it coherent to a listener. The definition of the word form cannot be separated from content (Latham 2011).

Even when considering all these elements, description of what music is can be very challenging. Birds sing completely rhythmically; their song conveys emotions for us, and it definitely has melody. The greatest composers have copied birds such as Beethoven in his *Pastoral Symphony* no.6, op. 68, or the recent composer, Herman Beeftink in his *Birds Flute Trio*. Humans tend to ignore bird songs as music because they are considered as alarming sounds or sounds necessary for mating (Montagu 2017). It seems that animal songs have survival values

while many philosophers believe that an important characteristic of art is that it does not exhibit any practical purpose (Wright 1994). Thus, any kind of music that is necessary for survival cannot be considered art. From the point of view of some evolutionary psychologists, such as Steven Pinker, music is not an adaptation process during evolution. Pinker, made his famous quote as, “Music is nothing but an auditory cheesecake.” He believed that music and its pleasure is sweet but empty and it has nothing to do with human’s evolution (Pinker 1997, 528-34).

There is another school of thought that music exists as NAPS (Non-Adaptive Pleasure Seeking) similar to the well-known human craving for sugar. Humans have no physical requirement for the amount of sugar consumed today and while our ancestors consumed sugar from fruit, the taste for sugar has evolved over time. This adaptation satisfies the rewards center in the brain but is problematic and can result in diabetes and heart problems. The same explanation can be expanded to pleasure drugs such as cocaine and heroin. The use of drugs is not necessary for evolution, but its pleasure-seeking behavior can be considered adaptive or non-adaptive through studying its life span in humans’ history. Non-adaptive pleasure-seeking behaviors are often short lived. For example, heavy drug users tend to develop serious health problems and are sometimes unable to function as good parents thus, the natural selection process tends towards eliminating drug users. What about music? If music is non-adaptive, then it should not have a presence in antiquity as archeological evidence. The oldest instrument found, a flute made of an extinct bear’s femur bone, was discovered in the Divje Babe cave in Slovenia (Turk 1997). It is suggested to be between 43,000 to 82,000 years old. Flutes are complicated musical instruments in comparison with the many drums and rattles found in regions settled by Native Americans. These simpler musical instruments predate the arrival of Europeans in America and it is possible they existed long before the flute. One might assume an even earlier

existence of musical instruments, such as those found in Slovenia, which were dated circa 100,000 years ago (Huron 2006). Huron speculates that singing existed even before musical instruments and estimates the existence of singing about 150,000 to 250,000 years ago which is double the time date proposed for the Divje Babe flute. The antiquity of music aligns with the basic requirements for an evolutionary argument. As Brown debates, music making is not only old, it is omnipresent. It is worth noting that the Divje Babe flute was discovered in a Neanderthal burial site indicating that music making started prior to Homo sapiens and has been common to the entire genus Homo (Brown 1991).

Additional evidence for a behavior to be adaptive is its consistency with survival. Anthropologist Dennis Werner has studied the Mekranoti Indians of Brazil and comparison with more other Americans is interesting. Men and women in Mekranoti tribe sing two hours a day with the men starting around 1:30 AM. The men sing in quadruple meter and accent the first beat using their deepest bass voice. They shake their stomachs violently with the rhythm and shout at men who are sleeping. They do this to wake up and join in the singing since they fear that other tribes will attack them. The amount of time the Mekranoti tribe dedicate to music is amazing (Werner 1984).

A modern human, in comparison with the Mekranoti tribe, dedicates an even greater amount of time to music making and/or listening. Huron (2006) states that the music industry is even larger than the pharmaceutical industry and people spend more money on music than they spend on medications. People purchase recordings, instruments, Spotify, and sheet music. They go to concerts, watch movies accompanied by music, purchase music classes and lessons, and are often involuntarily involved with Muzak much of the time. Millions of drivers listen to music in cars and trucks. Thus, music can be considered as a long-time evolutionary adaptation.

As another proof for the evolutionary aspect of music is supported by comparison with language. Certain anthropologists, such as Robin Dunbar, have introduced the “grooming and gossip” hypothesis. The grooming hypothesis proposes that animals are safer in groups, and they are always in danger from predators. The bigger the group, the lesser the danger from outsiders, but the danger of internal conflicts increases. Alliance in primates happen through physical grooming but the nature of grooming is that it is only one on one. Among humans, language developed as a tool for making bonds and a single person could talk to many people. Thus, Dunbar suggests that language evolved as a surrogate for physical grooming (Dunbar 1997). Dunbar, believes that effective conversation is only possible between four people. A larger group and people divide into smaller groups of four. Roederer (1987) argues that singing is a more effective way of bonding larger groups of people. Singing has the power to bring people together and to act in a similar manner. Even today, it is common for soldiers to sing or move (march) to music when preparing for war. Thus, singing can act both as a defensive mechanism, similar to the Mekranoti, or as an attack mechanism. Mekranoti men start singing at the time when one would normally be sleeping. This is the most vulnerable time for enemy attack but the sound of music has an advantage over sight since it functions better in the dark.

We assume that singing is even older than playing music. Morley considers that the necessary larynx shape, and the structural vocal capability of humans for singing, was shaped around 1.5 and 0.5 million years ago in Homo sapiens. Based on archeological studies, brain organization and hypoglossal canal for having the ability to speak or sing was developed in humans around the same time (Morley 2002). Singing could have been a tool for announcements of specific dangers. Daniel Levitin (2008) suggests that if an ancestor witnessed an attack of an alligator on someone close to the water, he would have tried to recreate the scene for his tribe. In

order to teach the young ones and for the sake of prediction, they needed to make the process a little theatrical and rhythmical. Dance and singing may have started this way. David Huron (2006) debates that the first song would have been more about pride than fear. Neanderthals who came back from hunting, would want to explain what happened (Levitin 2008). Speech and music have three similar methods of expression: vocal as in speech and singing; they can be gestural, as in sign language and dance, they can be written down as text (Mithen 2005). Both speech and music are structured by acoustic elements – tones or words combined into phrases or melodies. Although the nature of tones is different in music and speech. For example, when we say "dog", it refers to a specific entity but the word itself does not look like dog. Musical notes do not refer to any specific meaning. One can argue that high pitch notes imply alarm or warning such as sirens, but the pitch "C" is simply "C". Language is a tool used to communicate and to express ideas about daily, routine events as well as more complex theories or ideas about the origin of the universe. Alison Wray believes that the initial communication system used by the immediate ancestors of Homo sapiens in Africa was based on "Hmmmmm." Hmmmmm stands for holistic, manipulative, multi-modal, musical and mimetic. Wray explains that, at the dawn of language, communication was more holistic and manipulative than compositionally creative and different gestures were required for clarification. Little by little humans started breaking up holistic phrases into smaller units which referred to separate subjects. The ability to combine different units together led to a process of 'compositionality' which made language the most powerful system for communication. Thus musicality plays an important role in the perception of meaning and the movements of the lips helped other humans mimic the utterances (Wray 2000).

Even before Wray, Otto Jepersen, a linguist in 1920s believed that language started with music like expressions (Jepersen 1920) and Mithen added the dance like gestures with rhythm for early human beings for expressing their holistic messages including melody, timbre, and pitch for the expression of emotions (Mithen 2005). Evidence for this debate is the excavation of the archeological site in Bilzingsleben in Germany where homo-Heidelbergensis lived around 400,000 years ago. Dietrich Mania in 1970 found many animal bones, especially rhino and elephant bones, carved in different shapes in order to be used as tools for scraping the skin and cutting. Mania has also excavated a circular arrangement of bones. Although many critics do not accept Mania's theory interpreting those circular arrangements as huts, but Mithen suggests that they might have been spaces for performance, storytelling, and giving vital information either for preparation or entertainment through singing and dancing (Mithen 2005).

From the evolutionary point of view, the ability to predict outcomes has always been a great biological advantage which has helped survival. Over the past 500 million years, natural selection has been towards the ones who could form a better understanding of the future and thus plan for it. Accurate expectations as David Huron mentions are "adaptive mental functions that allow organisms to prepare for appropriate actions and perception" (Huron 2006, 3). This preparation should be done with the highest level of energy conservation. All living beings live on a specific level of energy. They need to recharge their power grid accordingly. Bodies naturally assume a static state when there is no challenging environment, the mind gets bored, and we go to sleep. But many animals can be hunted in a blink of an eye, and if not alert, this could happen for our ancestors as well. They needed to attain this preparation with a minimum of metabolic consumption of resources. As Huron mentions, there are two different systems related to metabolic consumption from a physiological point of view: attention, and arousal. Arousal is

interrelated with heart rate, perspiration, movement, and breathing. Attention is related to the brain and our focus on one subject instead of scattered thoughts. The brain areas that are involved in prediction and anticipation are substantia nigra, ventral tegmental area, anterior cingulate cortex, and lateral prefrontal cortex (Huron 2006). Attention and arousal and the responses of each individually, and in combination, can evoke emotional outcomes, either positive or negative. Positive states seem to be adaptive while negative outcomes are maladaptive (Huron 2006). Huron mentions five expectation-related emotion response systems as ITPRA theory. Each response is related to one biological purpose. *Imagination* response serves the organism's behavior for better future outcomes. *Tension* response prepares the organism to choose or combine the level of arousal and attention for the best outcome in the uncertain future. *Prediction* response evaluates the level of negative and positive aspects of the event for a more accurate presumption. *Reaction* response pictures the worst-case scenario for planning protective responses. The purpose of *Appraisal* response is to bring positive and negative biological strengthening of the outcome. The oldest response is Reaction response which happens unconsciously, and the Imagination response should have been the most recent evolutionary response (Huron 2006).

Humans consider all elements of ITPRA in making music. But still we can argue that if music was an evolutionary adaptation, its initial purpose could be fulfilled by language. In 1980s Gould introduced another concept as "exaptation," meaning a function which is a feature of an organism that takes a function different from its original purpose. The classic example of exaptation is the birds' feather which was originally evolved for warmth but later was used in flight (Gould 1987). Fitch (2006) debates that music is neither adaptation nor exaptation because it was once adaption but still it is not vestigial and plays a great role in human behavior. In the

end, as Fitch concludes, we may never be able to prove if music has been adaptive in the human evolutionary process or, as Pinker says, simply auditory cheesecake. The point is that music evokes emotions which are the basis for various human behaviors.

It is extremely challenging to explain emotions. Although scientists agree that there are several basic emotions engraved in the human genome and Homo sapiens would experience all of them. Fear, sadness, happiness, anger, and disgust have been with us for six million years (Mithen 2005).

Victor Bennett has given one of the best explanations for emotions as, “The normal state of the soul is one of contentment, or relative contentment at least; but when in reality or imagination it becomes aware of something that can be a source of pleasure to it, the soul yearns towards that thing, and when it becomes aware of anything that menaces its well-being, the soul averts itself. These movements to and from the passing vision of reality are the emotions” (Bennett 1942, 408).

Another question is, why do humans have emotions? Psychologist Keith Oatley mentions that human beings should always choose an action or behavior, from fight or flight, to continuing an action or stopping one, from completing an action or changing to another. For making these decisions, humans have limited time and limited information, thus making decisions based on pure logic is very difficult and it is emotion which comes into the situation where there is lack of time, or conflicting aim, or imperfect knowledge. We always set a goal and sub-goals before starting a task either consciously or unconsciously. By achieving the sub-goals, we feel happy, and this emotion is the drive to continue the task or a similar one (Oatley 1987). In the social world our emotions are related to our social relationships.

Emotions show themselves in human's behavior and alterations in the body such as laughing, crying, or even physical ease or uneasiness. People learn to keep the physical or outward alterations of emotions in control. Various researchers, such as Simon Baron Cohen, note that human emotions have evolved to make us more intelligent. Humans have learned to express their emotions and read the emotions of others. One method for expressing emotions is making music (Baron-Cohen 2003).

Bennett suggests three elements for something to be called music: Physical, form, and mimetics. Tonal music always consists of a center key and there will be tension and release towards this center. Emotions always move between tension and release. Thus, emotion is connected to musical representation (Bennett 1942).

The concept of representation is debatable between scientists. There are two different point of views in regard to the claim that music represents emotions. Resemblance theory of musical expression supported by empirical science, which claims that music expresses emotions because it portrays the expressive behavior of humans (Young 2012).

Another point of view is the claim that music arouses emotions. Young (2012) debates that for something to functions as a representation it needs to have content or cognitive importance. The representation should have information about the objects it represents. Another condition for something to be a representation is that the cognitive significance should be intentionally given to it by another person and at last only a qualified group of audience should be able to recognize this significance. For example, a painting can be a representation of Beethoven only if it gives the viewer some knowledge about Beethoven. But this explanation hardly relates to a piece of music. The learned audience can grasp the key of the piece, or the tempo, or the time signature but this information is about the composition not the music as

meaning. The music should be able to give us something beyond music itself, something such as content able to represent emotions. Intentionality is an important key. For example, if autumn leaves fallen from a tree create a visual image which resembles Beethoven's face, we cannot say that it represents Beethoven. It was "created" by accident. Most composers do not intend to represent anything and although they may use bird song, but there is no intent to represent any emotions by including such content.

It is easy to represent emotions to music with resemblance theory. Many music pieces are heard by educated listeners and these pieces evoke emotions in the listener. Most of the musical pieces are intended to evoke emotions which means they have cognitive significance. Thus, music represents expressive emotions (Young 2012). Although, we should keep in mind that sometimes musicians don't intend to express any emotions in their music. Furthermore, as Aristotle says, art is not representation of the "state of character" but simply it represents the "indications" of a character. He debates that a painting can represent the expression of melancholy but cannot represent melancholy itself. It is an indication of a person's interior state not the melancholy itself (Young 2012). But Aristotle makes an exception for music because music can arouse expected emotions, and this leads to accept music as a representation of the "state of character." Aristotle in his book "Politics" states that:

> With musical compositions, however, the case is different. They are in their very nature, representations of states of character …In the first place the nature of the modes varies; and listeners will be differently affected according as they listen to different modes. The effect of sadder and graver temper- this is the case, for example with the mode called the Mixolydian. The effect of others (such as the soft modes) is to relax the tone of the mind (Aristotle 1946, 344).

There are many other thinkers who have the same opinion. Jean Jacques Rousseau, a Genevan philosopher and composer of the 18th Century, mentions that,

> The art of the musician consists in arousing in listeners movements of the soul that is emotions. The musician will not directly represent things but excite in the soul the same movement which we feel in seeing them (Rousseau 1775, 198-99).

Although the concept of music representing emotions is very controversial, but by defining the word, “representation” and based on empirical evidence, we can conclude that music intentionally arouses emotions with a cognition significance. Thus, music represents emotions.

We can understand the world through our emotions and our behavior is based on our emotions. Music is an art that evokes emotions thus this question arises that what is music and if there is a point for music as an art? As discussed preciously, anything which has been unnecessary for evolution or survival has vanished from human history yet music is woven into the daily lives of humans more than ever. Michael Morris introduces a cognitivist approach in response to this scenario. “Cognitivism about music is the view that the point of music as an art is to put us in a position of being right about the world because one is attuned to the world (Morris 2012, 556).” Morris believes that the point of music as an art is to help us understand the world better. Listening to a piece of music has the potential to connect us with the meanings of things around us.

But what about pure music? What is the definition of pure music? Is improvisation an example of pure music? Composed music is not that much different than improvisation since it is originally improvised in the mind of the composer and the only difference is that the composer has the chance to change, edit, adapt, and notate the music after it is improvised. This is very different than other art forms such as realistic painting. The painter draws what she sees in front of her but not even the most representational music is composed in that manner. Michael Morris

offers an explanation to take this even further. In comparing an improvisational piece of music with abstract painting he states that abstract painting is,

> It is natural to think that abstract painting gets its significance from its figurative painting whose legacy of expectation it constantly exploits. It seems that the direction of dependence runs the other way in the case of music: that it is the antecedent significance of what we might call abstract music, constructed experimentally in the first instance, which fits for the later task of representing such things as the sea - not a prior tradition of representation which creates the possibility of significant abstract music (Morris 2012, 563).

Thus, Morris doubts that improvised music is a representational art form and since music is an improvisatory art form it does not follow any preconception in its representation. In giving a meaning to music we can just talk about how we feel while listening to the music and these descriptions lead us to preconception view of representation related to music. We can describe specific music as sad, uplifting, etc. Describing music is almost impossible because the terms we use to describe music are either related to people or to the things which are similar to people (musical persona) (Levinson 1990). On one hand, musical persona does not necessarily relate to feelings, and we can use terms such as “majestic” or “delicate” which do not arouse any emotions. On the other hand, the musical persona does not have any place in improvisation thus, we should use another term to describe pure music. The concept of *metaphoricalism* can solve our problem. When we find a music to be “sad,” it does not mean that the music is sad itself, it means that the music arouses the feeling of sadness which may have different responses in the outside world due to this feeling. Hence, there is a connection between feelings and the situations in the world. Morris debates that,

> the sadness of music is a distinctively proper response to the sadness to be found in situations - where a distinctively proper response to the world is the analogue, for artistic media to the specifically to the proper response to the world which a feeling may be (Morris 2012, 574).

Tragic music is a distinctive proper response to a tragic situation. The word tragic is used to show the relation between the feeling we have due to the situation in the world. Morris debates that sad music represents the sadness which a situation can impose, and tragic music represents the tragedy which life can have, and majestic music can represent the majesty in things (Morris 2012).

The cognitive ability of representation is what characterizes the musical brain. Levitin (2009) combines the concept of representation together with perspective taking and rearrangement as the characteristics of the evolved brain mechanism in humans for development of both language and art. Levitin believes that these three faculties gave the early humans the ability to define their world. Art represents the world around us in a way that is not necessarily the way it is. We all know that what we are feeling is not exactly what others are feeling but in order to make social bonds humans made language, art and music. Michael Morris believes that when we listen to a music our focus is neither on the musical persona nor on our feelings or others' feelings, but promptly on the feeling as a property in the world to which the music is a perceptive response. Thus, we can understand the world through music (Morris 2012).

Among all arts, "Music combines the temporal aspects of film and dance with the spatial aspects of painting and sculpture, where pitch space (or frequency space) takes the place of three-dimensional physical space in visual arts" (Levitin 2009, 17). In conclusion, music is a medium for understanding the world around us and the feelings which are perceived in this world. The arousal of the emotions is the result of simultaneous activity in different parts of the brain. Research has shown that positive emotions increase both satisfaction and resilience in life (Cohn et al. 2009). By studying the musical brain, we may discover new ways to use this precious medium for improving the quality of life for humans.

Chapter 2: The Human's Musical Brain

It appears that music has always been present in all aspects of human culture. Its purpose has served a large spectrum from entertainment to healing. Nietzsche, the great German philosopher, musician, and poet of the nineteenth century famously quoted: "without music, life would be a mistake" (Nietzsche 1889). Many scholars have been curious to understand why music can produce different impressions on people. Scientists today know that a large network in the cortical and subcortical regions of the brain and bilateral, frontal, and parietal regions are engaged while listening to or making music (Zatrorre et al. 2013; Koelsche 2014; Gordon et al. 2018; Freitas et al. 2018). Amusia (the inability to perceive pitch in music) or acquired amusia (the impairment in music production with a neurological basis), give researchers the opportunity to find out more about the critical parts involved in the musical brain (Price et al. 2002; Rorden et al. 2004). It is necessary to mention the importance of the auditory system in relation to music which itself is a very big subject. Many scientists from physicists to neuroscientists have done a vast amount of research on the performance of the auditory system and sound (Moore, Linthicum 2009; Nelken 2008; Oxenham 2018; McDermott, Oxenham 2008). However, sound is not the subject of this chapter.

Music is perceived thorough a network of connections. There are three theories about the musical brain: 1) the triune brain theory. 2) left brain – right brain theory. 3) the holographic brain theory.

1) Dr. Paul Mac Lean (1980) introduced his triune brain theory. He explained that human's brain has evolved with the forebrain region while still holding on to reptilian parts and parts which are common with other mammals. Although these three parts of the human brain are different in structure and chemistry but are all connected in a hierarchy form

which makes it feel that humans have three brains in one or in short, triune brain. Thus, we can see the world with three different mentalities and different intelligences. The first brain is the lowest part of the brain stem which is same as the reptilian's brain and is responsible for our physical space, survival modes and desires. The role of this brain in music is that since the physical and biological functions of the body are related to this part, when a musician misses his music sheet or something unexpected happens during the performance, the reptilian brain activates. The mammalian brain is consisted of the limbic system which is involved in emotions. This part of the brain is very active in musicians not only in the process of performance but also during competition with other musicians. The third part in the human's brain map that Maclean mentions is the neo-cortex. This part is responsible for new ideas, creativity and decision makings which are all related to music. During playing music or listening to music there is a network cooperating between these three parts (Maclean 1980).

2) In 1981 the Nobel Prize was awarded to Dr. Roger Sperry for his split-brain research. He conducted research on the importance of corpus callosum in adults which connects the two brain lobes together. He noticed that two different consciousness resides in each lobe of the brain. Since his research was on epileptic patients, he noticed that by disconnecting the two lobes through corpus callosum, for example, the right hand didn't know what left hand is doing. Sperry concludes that the right hemisphere is superior to the left hemisphere in regard to the capability of concrete thinking, spatial awareness and comprehension of complex relationships as well as interpreting the intonations and differentiating between sound and musical perception (Campbell 1996).

3) The holographic brain theory looks at the human's brain as a single unit. Karl Pribram (1991) a neurosurgeon in Stanford who introduced the holographic model of the brain in his research on memory, believed that the brain is based on mathematical principles similar to a hologram. Similar bits of memory and information are stored as a quantum field integration in different parts of the brain. Later, Pribram proved that the dendritic arborization are related to perception and the neural wave form of the dendritic network is similar to the quantum wave form (Pribram 1991). Each neuron has the capacity to store millions of bits of information. This information produces waves that encode other neurons with the same frequency. This theory implies that in music: "Every tone is held within a single tone. This implies that all sounds are held within the overtones and harmonics of each fundamental pitch" (Campbell 1996, 33).

Researchers in neuroscience are continuously working towards a richer understanding of the musical brain. At the dawn of the twenty-first century, with the fast-paced revolutionary progress in technology, the subject of neuroscience has become a superstar. Although, many thinkers such as Jonah Lehrer have come to the conclusion that everything cannot be known and the things we cannot explain can be considered "art" (Lehrer 2009). The prominence of art is leading to the rise of a new field in neuroscience referred to as "neuroaesthetics". Based on the definition of Suzanne Nalbantian (2008), "neuroaesthetics is the study of the neural bases for the contemplation and creation of a work of art." This emerging field of neuroscience studies the reasons for why humans make art such as music and why they enjoy it.

The human brain has evolved into a system that can analyze sound for meaning. Music perception seems to be unique to humans, with studies on animals determining they do not show

any preferences between music and other sounds (Kolb et al. 2016). Humans gather together and sing songs or play music and dance in a wide variety of events. There are two main branches for studying the cognitive neuroscience of music, 1) music with respect to emotions which leads to neuroaesthetics, and 2) the perception of the musical structure which constitutes a more cognitive approach. The study of the human brain with respect to music begs the question, why do people make music, how do people perceive music, and how does music have an impact on the physical body of humans as it relates to movement and dance (Helding 2020). Different brain areas are involved in music production and music perception. These regions were first discovered by studying Maurice Ravel, a famous nineteenth century composer (1875-1937). After he experienced a left-hemispheric stroke, Ravel's music perception abilities remained intact, however, he could not compose any music and lost the ability to play the piano (Kolb et al. 2016). Results of this study suggest that the left hemisphere is dominant in making music and the right hemisphere is more dominant in perceiving the music (Kolb et al. 2016).

Music perception is often accompanied by emotions. Many parts of the brain are associated with emotions. Gosselin and colleagues showed that the amygdala has a crucial role in emotional processing while listening to music. They noticed that a patient with medial temporal bilateral resection around the amygdala, confused menacing music as peaceful (Gosselin et al. 2007). Trost also mentions that the amygdala is activated during hearing dissonance (a disturbing sound made of combination of disharmonious notes) (Trost et al. 2012). The concept of sad emotions induced by music is related to preference of major or minor scales. Why people prefer to cry with particular kinds of music is still unknown. Mitterschiffthaler et al. (2007) studied fMRI scans of 53 participants while listening to 20 different pieces of classical music, which varied between neutral, sad and happy. Results showed no specific brain regions activated

showing sadness while listening to music. Mitterschiffthaler and colleagues noticed that the hippocampus and the amygdala become highly activated with both sad and happy music while the right hippocampus and amygdala area became activated with sad music, when compared to a neutral tone. Researchers also noticed activation in the ventral and dorsal striatum, especially within the caudate, anterior cingulate, parahippocampal gyrus, and auditory association areas when participants listened to tunes which induced happiness. Mitterschiffthaler discovered an emotion processing network in response to music activates a network combining the ventral and dorsal striatum, areas known to be involved in reward experience and movement; the anterior cingulate, related to attention; and medial temporal areas, related to the processing of emotions. Interestingly, the left posterior insula showed activation during listening to neutral music (Mitterschiffthaler et al. 2007).

Our Euphonious Island: Music, Dance, and the Insula

Insula, meaning “island” in Latin, is an interesting, yet mysterious part of the brain. There was not much known until the early nineteenth century when J. C. Reil, a German neurologist, introduced its discovery (Neidich et al. 2004). It is located deep within the lateral sulcus and can only be accessed by removing the temporal and frontal lobes of the brain (Neidich et al. 2004). In humans, the insula has connections with various parts of the brain such as frontal, parietal, and temporal lobes; the cingulate gyrus, amygdala, brainstem, thalamus, and basal ganglia (Flynn et al. 1999). The insula is divided into three sections: anterior section (AI), posterior section (PI) and middle section (Flynn et al. 1999). PI represents the physiological condition of the body which will be integrated in the mid insula and in the AI consecutively. The PI and the mid insula are associated with sensory motor functions. Furthermore, the AI can be studied in two parts: ventral part of the anterior insula (vAI) and dorsal anterior insula (dAI). The dAI is involved

with higher levels of cognitive control, and the vAI is activated through affective processes (Udin 2014). The AI is the most developed cortical area in humans in comparison to other primates (Bauernfeind, 2013). Another significant property of the AI is containing large spindle shaped bipolar neurons called Von Economo neurons (VEN) which are 4.6 times longer than pyramidal neurons that make the long-distance exchange of information possible (Seeley et al. 2012). The Right vAI contains more VEN neurons, which are related to affective circuits (ibid 2012). There is an asymmetry in function between right and left insula which may be due to the differences between ascending and descending connections that utilize different frequency bands depending on feedforward or feedback communication (Bastos et al. 2015).

As the name suggests, the insula is a unified center that connects differential functional systems such as: sensory, emotional, and cognitive processing. The insula is associated with processing positive, negative, and social emotions (Gogolla 2017). The role of the insula has been studied with respect to emotions, memory, and even proprioception, yet its role in relation to music has not been fully studied. In research on people with Parkinson's disease (PD), the insula becomes activated during dance as shown in the fMRI studies which show the relationship between moving to music and the insula (DeSouza 2017). It is important to review present papers about the insula to better understand the role of music and its effects on this part of the brain in order to produce a reliable brain map to facilitate further studies.

With the advancement of neuroimaging machines such as fMRI, Antonio Damasio became the first person to be interested in the insula and subsequently published a paper about its relation to emotions, memory and general homeostasis (Damasio 2011). Each human experiences a chemical change to either interoceptive system or exteroceptive system. The

interoceptive system is considered basic to individual drives, for example: hunger, thirst, sex, and aversion for pain (Berridge 2004). Exteroceptive systems include emotions such as fear, sadness, joy, compassion and admiration all of which have a great role in social regulations (Immordino-Yang 2009). The body is constantly working to organize these systems to maintain homeostatic balance as it relates to drives and emotional regulation, as it relates to both the needs of the individual and social aspects (Damasio 2011). Habibi explains that although music is not necessary for survival, people often feel the expressive properties instead of feeling responsive properties while listening to music. This means that even though they don't become angry or frightened while listening to music, they feel the anger or fright in the music. Thus, one can infer that music engages one's innate physiological action programs in order to maintain homeostatic balance in one's physiological state (Habibi 2014).

Music and the Insula

The insula has reciprocal interconnections with auditory system (Pandya et al. 1985). Zhang through EEG experiments showed that insula is involved in auditory processing (Zhang et al. 2019). Auditory agnosia can happen with a bilateral insular lesion (Bamiou et al. 2003). Based on the 2019 research of Zhang et al., the posterior insula (PI) is activated more when exposed to auditory responses whereas the anterior insula (AI) is activated due to emotional responses and affective responses (Zaki 2012). Since music involves both auditory response and emotions, we are able to study the role of insula for music.

Listening to music produces changes within the autonomic nervous system such as heart-beat rates (Trost et al. 2012). Music also produces changes within the Central Nervous System (CNS) such as the insular cortex to contribute to the positive direction of homeostasis (Trost et al.

2012). Music can be divided in to two types of pleasant and unpleasant tunes. Pleasant music can be defined based on the connection of the positive emotion network consisting of ventral striatum and orbitofrontal cortex and an increase in activation of the dorsal amygdala versus unpleasant music which reduces the activation of central regions of the amygdala (Blood et al. 2001). We can also define the pleasantness of a tune from the dopamine release in the striatum (Salimpoor et al. 2011, 2013). Damasio (2014) showed that pleasant music activates the insular cortex which is related to changes in the autonomic nervous system (Habibi 2014). Koelsch et al. (2006) showed that the insula would be activated while comparing a pleasant music to non-pleasant and listening to a joyful music versus resting (Brown et al. 2004). Since the insula is bilateral, we can study the differences between each hemisphere as well. Nazemic et al. (2013) showed that the left insula is more activated than the right insula due to unexpected sounds.

The effects of music on the brain can be studied from three different angles: listening to music, making music, moving to music.

- **Listening to Music**

Music has different components such as melody, harmony, texture, timbre, structure, rhythm, and tempo. The relationship between music and emotions has been studied since Plato. Trimble and colleagues mention that “Music reveals the nature of feeling with a detail and truth that language cannot approach” (Trimble 2017, 29). Blood et al. (1999) showed that the right hemisphere is more dominant when experiencing emotions while listening to music. It has been observed that even imagining music can activate the right hemisphere more than the left (Blood, 1999). Dominance of one hemisphere has been studied in regard to different components of music as well (Thaut 2014).

An important component of music is its rhythm. Lappe (2013) showed that the rhythm activates the right insula. She did her research on ten non-musicians with eight trained sessions to play a rhythm on piano. The stimuli were generated through an audio workstation. The magnetic field responses were recorded through a magnetometer system and MR scans were obtained from each participant. It is worth noting that Lappe didn't mention any activation of the insula as it related to melody or pitch. She does mention significant neural activation, specifically in the right hemisphere in superior temporal gyrus (STG), inferior frontal gyrus (IFC), superior frontal gyrus (SFG) and occipital frontal gyrus (OFG) (Lappe 2013).

Rhythm can be understood through a sense of beat, and individuals can perceive the beat differently. Based on a study by Grahn et al. (2009), 35 participants were asked to identify a sequence of intervals as either speeding up or slowing down. Last intervals less than 600 beats per milliseconds were considered speeding up and final intervals longer than 600 beats per ms were considered slowing down. Grahn (2009), noticed via fMRI scan analysis that the left insula is activated in the strong beat-perceivers while weak beat-perceivers showed greater activation in the right premotor cortex (Grahn 2009). A year after Lappe, Thaut and colleagues (2014) studied activation of different parts of the insula due to different components of the music on five musicians and five controls. The participants should differentiate between different paired rhythms, different paired melodies and different paired tempos and rest. Results of nine PET scans showed that melody activates the right anterior insular cortex (AI) while tempo activates the posterior insular cortex (PI) due to the involvement of somatosensory regions and premotor areas (Thaut 2014). Craig (2009) stated that the right AI is activated due to the stimuli which cause arousal in the body for example pain, while the left AI is activated due to the associated feelings from the same emotion. For example, looking at a picture showing someone in pain or

hearing pleasant music (Craig 2009). Petrini et al. (2011) reviewed the fMRI scans of 16 participants without any musical training in order to find out about the relationship between connectivity of different parts of the brain and the insula. They used music as auditory stimuli and compared it with music and visual display. They showed that the right AI is activated by both auditory and visual aspects of emotional musical stimuli, while the left AI is activated only with sound of the emotional music. Bodily movements of the musician regulate the brain activity made by music. Audiovisual stimulus makes the understanding of emotional content of the musical sound easier (Petrini et al. 2011).

We can show that listening to different kinds of music with different tempos or rhythms can change the heart rate through different parts of the insula. Shodha (2016), found differences between live music and recorded music on the heart rate (HR) of 37 audience members. Seven pianists would perform pieces while recording of the performance were also produced. After listening to the live performance, the audience were asked to listen to the recordings of the songs. The electrocardiogram (ECG) results indicated that live music increases the HR more than recorded music in fast songs. Furthermore, researchers observed that the participants' stress levels were lower while listening to live music (Shodha 2016).

On the other hand, familiar melodies activate different parts of the brain. Mutschler and colleagues (2007) studied the fMRI scans of ten subjects; once after listening to a piece of music that they had learned previously, and once after listening to an unfamiliar melody. They noticed that active listening, stimulates the left anterior insula (AI). The activation of the left AI was observed to extend to the left fronto-opercular cortex which spreads to the insular sensorimotor hand area (Mutschler 2007). The left anterior insula (AI) retains a somatotopic map that represents hands, fingers, legs and shoulders. Reactivation of these parts of anterior insula (AI)

can be considered proof of mirror neuron properties of the insula. Mirror neurons are visuospatial neurons responsible for human social interactions and activate during watching others and imitating. Mirror neurons fire during both action and observation and enable us to reflect our body language and emotions through imitation (Fink 1997). The action-observation network is a network of different brain regions such as occipito-temporal, parietal and premotor cortex that supports visual perception of actions (Burcu 2019). The mirror neuron network is related to action-observation network which is engaged in musical and dance training (Brown et al. 2006).

- **Making Music**

Making music requires creativity. Brain networks for musical creativity have been studied by many researchers such as Pinho (2018) and Ritter (2017). Musical creativity can be divided into conscious creativity and unconscious creativity. Conscious creativity is either based on knowledge or experience. Beaty et al. (2016) studied musical improvisation as a domain specific creativity. They showed through fMRI scans that during the process of deliberate creativity, the connectivity between posterior cingulate cortex (PCC) and control network such as dorso-lateral prefrontal cortex (DLPFC) and the salience network such as the insular cortex increases. In the case of the insula as a salience network, the role of the right insula is more noticeable (Beaty et al. 2016). However, creative thoughts can be understood in two stages: idea formation and idea assessment (Fink et al. 1992). Idea formation involves a bottom-up process of engaging a wide network related to defused attention, while idea assessment involves fused attention and cognition (Jung 2013). De Aquino et al. (2019) has studied the fMRI scans of 21 musicians and 21 non-musicians in regard to creativity and have compared spontaneous creativity and deliberate creativity. Based on previous studies, the brain regions which become activated during

creativity are the dorso lateral pre-frontal cortex (Chen 2014) and the anterior dorsal cingulate cortex (Luo 2014). De Aquino and colleagues (2019) determined that the anterior insula (AI) is active in both groups of musicians and non-musicians during improvising but is more active in non-musicians while improvising. Based on the evidence, the researchers concluded that given the experience of non-musicians' participants, the emotional network is more activated than the cognitive network in the AI (De Aquino et al. 2019).

- **Moving to Music**

Moving to music or dancing as an "orchestration of energy" is an encompassing biochemical experience. Repetitive movement patterns such as diagonal or straight hand movements, hopping, displacement of the feet, cutting edges sharp and soft, and moving the gaze – all these constrict and dilate our blood vessels. All movements fire millions of neurons and trigger a rush of neurotransmitters in the brain, together induce different sensations and emotions (Dils et al. 2001).

> Dance is a language. Its logic is not discursive but lyric. Like music it's a force field, an orchestration of lines and force, lines of energy, and that is the only way to start understanding it. Dance is not a story; it is a song (Dils et al. 2001, 13).

Based on choreographer Mark Dendy, "Dance is a contemporary ritual and a spiritual opportunity to share energy, join in a sense of communitas" (Dils et al. 2001-xiii). Although dance as a ritual has been a part of humanity since ancient times, looking at the history of dance is chronologically impossible, and in its stead, it must be examined topographically.

Dance does not belong to a specific group of people, and its purpose is not only to be visually pleasing but to explore the beauty which already exists within. To dance, one does not require a perfect body shape or a specific physical condition but rather a passion for movement. Ann

Cooper Albright, an American dancer and scholar, has focused her research on dancing with disability. She worked with the *Cleveland Ballet Dancing Wheels* and concentrated on movements designed for limited standards of fitness (Cooper Albright 1998). During her career, she tried to replace the stereotypical definition of dance, being only an activity that portrays beauty, with a more conventional definition of experiencing pleasure in movement through the satisfaction of individual needs (Dils et al. 2001). Dance can yield the need for healing and has been used as a healing component from ancient times. Today, this "old" application is found among Shamans, Sufis, and other spiritual traditions around the world. To this end, Marian Chace began the new age dance therapy in St. Elizabeth's psychiatric hospital in Washington D.C to help the Post-World War II casualties.[1]

Moving to music or dance has also been of interest to gerontologists in recent years. The function of the motor units in the spinal cord and myelin sheaths around ventral root fibers decreases with aging which can lead to a reduction on the gait speed, balance, and motor functions (Lexell 1997). The concept of a 'motor reserve' has come into the spotlight for the older adults in recent years. Debra Fleischman (2015) conducted a study on 167 adults with a mean age of 80 who participated in an 11-day study for "Rush Memory and Aging Project". Analysis of the results concluded that physical activity preserves the motor function against the effects of brain pathology due to old age (Fleischman 2015). Physical activity is referred to "Motor Reserve" and is something necessary to act against the natural aging process and neurological disorders. One needs to consider the positive influence of moving to music on

[1] https://www.adta.org/marian-chace-biography

motor reserve in his or her life and implement movement into a routine to prevent motor degeneration (Fleischman et al. 2015).

Dancing and listening to different kinds of music with different rhythms influences one's heart rate. Stephan Oppenheimer (2006) showed that the right insular cortex has a higher level of activation within the sympathetic cardiac neural function. Based on his study the right insula has a greater role in elevation of the diastolic blood pressure and increasing the heart rate, while the left insula remains dominant in parasympathetic cardiovascular regulation and bradycardia (Oppenheimer 2006).

Few researchers have studied the role of the insula in dancing. In 2018 over a time frame of six months, Rehfeld and her colleagues studied 38 brain scans of elderly individuals with dance intervention and compared them to an age-matched active control group who did sports activities other than dance. They noticed that dancers developed wide-spread gray matter in various parts of the brain, including the left insula (Rehfeld et al. 2018). Since the insula is a hub, whose network interacts with memory and attention centers (Mayer 2007), we can expect the insula to activate extensively during dance. It should be noted that Rehfeld et al. (2018) and her team studied the brain of elderly dancers while they were being trained in different styles of dance compared to the active control group, who were doing repetitive movements which didn't require much attention or memorization after a few sessions. Beatriz Calvo-Merino (2005) studied the brain scans of ballet dancers and capoeira dancers by showing them a three-second silent video of dance. Results found that activity of premotor cortex only increased when the dancers were familiar with the genre of dance (Calvo-Merino 2005).

Visualising Moving to Music

In Dr. DeSouza's lab in June 2022, my colleague and I studied the fMRI brain scans of ten people between the ages of 52-83 with Parkinson's disease who were taught choreography for over 34 weeks at Canada's National Ballet School in Toronto. The participants were required to practice the dance choreography at home physically and, also mentally by imagining or visualizing the dance. All participants underwent at least one to a maximum of four MRI scanning sessions at Sherman Health Science Research Center at York University over a period of seven months. They listened to the rehearsed music (Aaron Copland *Hoe-Down*) and imagined the dance choreography while in the fMRI scanner. The music would play for one minute and stop for 30 seconds and repeat. A block-design was employed (Fig. 1) where 60 seconds of the dance-imagery task (ON state) alternated with fixation blocks of 30 seconds (OFF state) where the participants were instructed to stop imagining the dance. These blocks were alternated and repeated five times for both blocks with a total of 7.5 minutes. The four timepoints were: pre-training (T1), where the participants heard the music for the first time and had no prior knowledge of the dance choreography; after 11 weeks of training (T2); after 18 weeks of training (T3) and after 29 weeks of training (T4).

All ten participants were scanned after the first week. For the last sessions, two participants were scanned on the third timepoint and four participants were scanned for the last timepoint for a total of six participants for the last two scanning sessions.

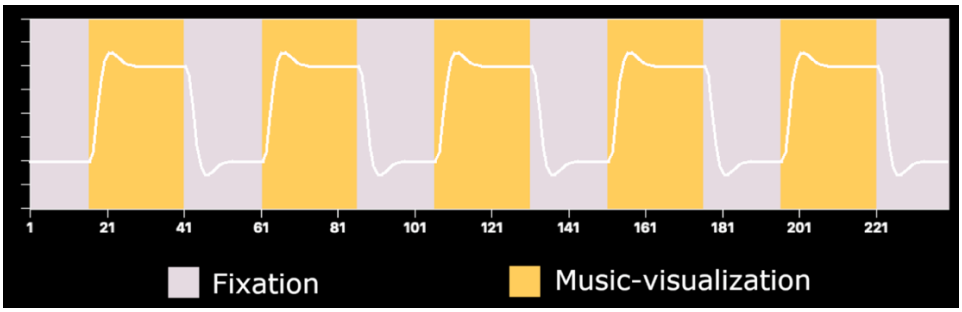

Figure 1:Scanning paradigm: five blocks of 60s 1 (=30 TRs) of the dance-imagery task were alternated with 30s (2.0-sec (TR) fixationblocks. The white waveform has the hemodynamic function convolved with the boxcar stimulus.

The functional data of the fMRI scans were analyzed using General Linear Model: Multi-subject in BrainVoyager QX to investigate dance-imagery compared to no music. The results of the study demonstrated activation in the network of brain regions (motor areas, auditory and insular cortices) during the first week, and an increase activation of the same areas during the last weeks.

Based on the research of Rehfeld (2018), we hypothesised that the insular activation should increase with dance visualization during the 34 weeks of training. The following graph shows the average activation of the right insula of the ten participants in the first week and the average activation of the right insula of the six participants on their last week of dancing **(Fig2**). Although we may expect an increase in the activation of the right insula during time, but the paired T-test shows a non-significant mean increase in the right insular activity between the first and last time point. Data analysis done with R Studio is as below:

t= -0.95995, df= 35, p-value= 0.3437.

Alternative hypothesis: true difference in means is not equal to 0.

95% confidence interval: -0.027510231, 0.009846112. Sample estimates: mean of the differences -0.008832059.

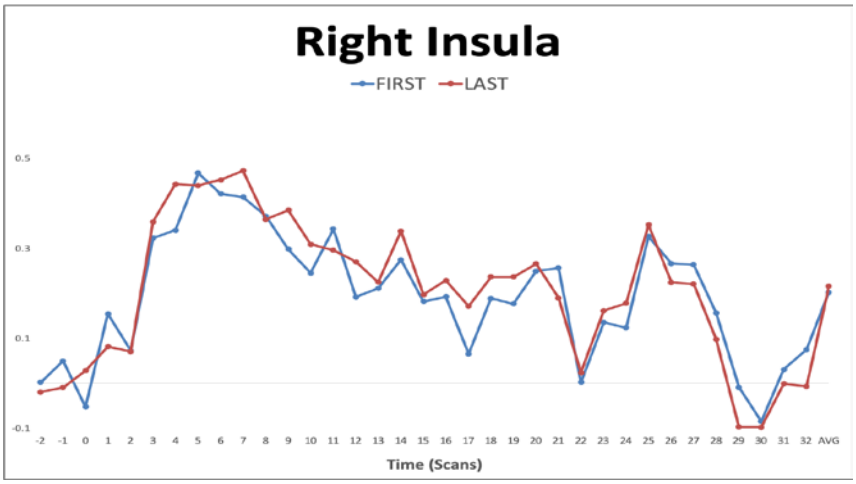

Figure 2.The average activation of the right insula of the ten participants in the first week and the average activation of the right insula of the six participants on their last week of dancing.

For the purpose of studying the insula specifically, I chose a single subject. Patient DD was a 69-year-old male with Parkinson's disease who participated in all four-fMRI scan sessions for 29 weeks. DD would practice the dance choreography 4.5 hours per week at home and visualize the dance choreography without physical activity for 0.5-1 hour per week.

Linear modelling was then used to analyse modulation of task related percent BOLD signal change (imagery vs. fixation) between timepoints for each of the functionally defined ROIs. For right and left insula, linear mixed-effect modelling (LMM) was conducted with timepoint as a fixed factor and individual samples included as random intercepts.

There was a significant main effect of timepoint for the right insula (b = .0015, SE = .00023, t(308.2) = 6.57; p <.001). There was a decrease in activation between T1 and all other timepoints: T2 (t(205) = 5.47; p <.001), T3 (t(210) = 5.43; p <.001), and T4 (t(210) = 8.65; p <.001). Although the left insula showed an overall pattern of signal change similar to that in the SMA and STG, the main effect of timepoint was not significant (b = .00020, SE = .00021, t(312.6) = .95; p =.34).

As previously stated, and based on the research of Rehfeld (2018), we hypothesised that the insular activation should increase with dance visualization during the 34 weeks of training. The chart following shows the average activation of the right insula of a single participant, Patient DD, during the four weeks of visualizing the dance under the fMRI scanner and the average activation of his right insula in each week of visualizing dancing. Although we may see an increase in the activation of the right insula at the beginning, but the slope of the activation bars decreases over time (Fig 3).

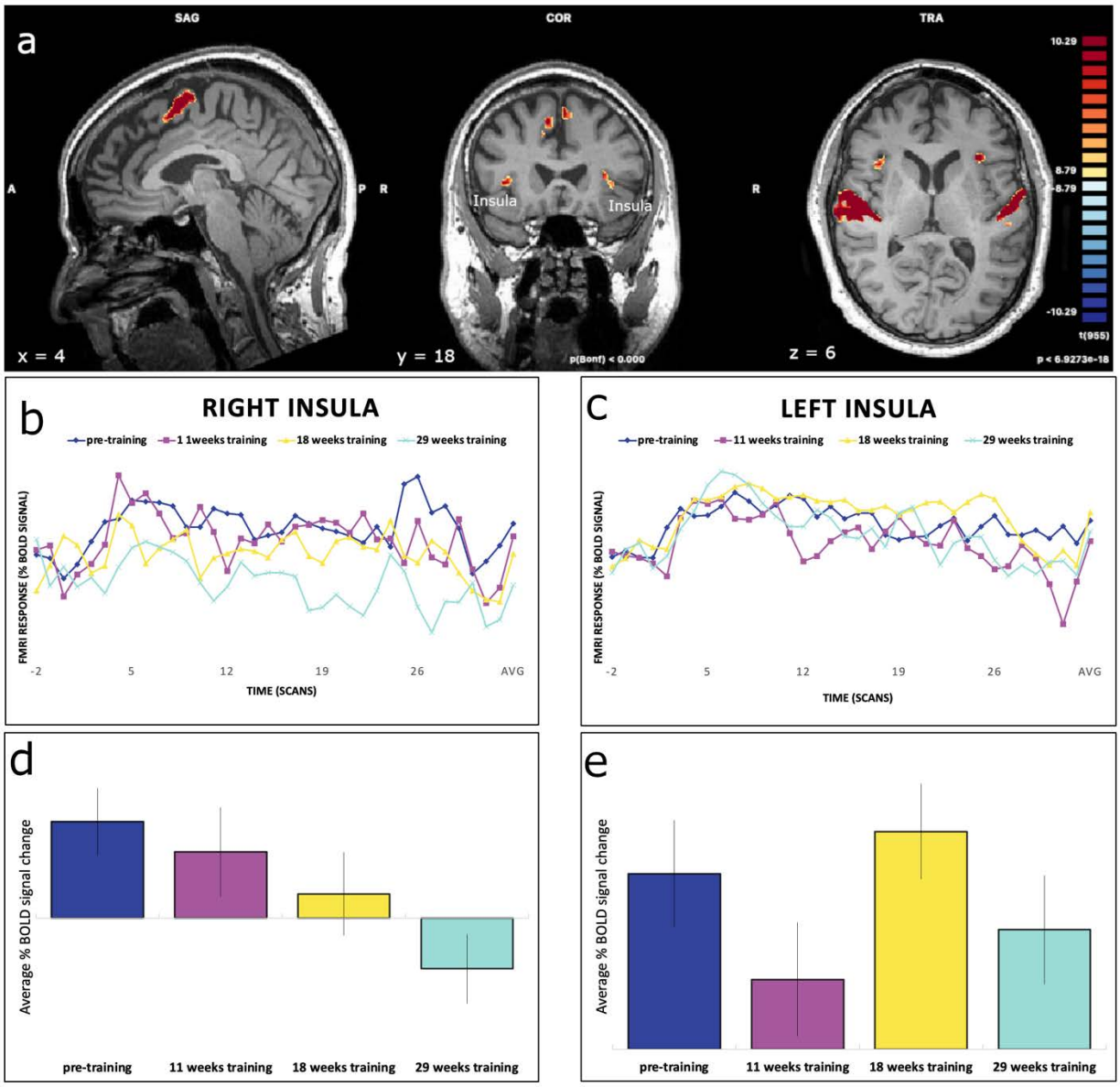

Figure 3. Imagery related activation of right and left insula during the imagery condition shown in sagittal view in the 3D Talairach space, displayed at a statistical threshold of $p < .0001$, Bonferroni-corrected, cluster threshold $k > 22$. Functional MRI response (percent BOLD signal change) of right insula (b) and left insula (c) during imagery condition within each of the four time points. Average percent BOLD signal change of right insula (d) and left insula (e) between the four time points. Error bars represent S.E.M.

During the pre-training period (T1) this individual did not know the choreography thus his movements were more like improvising to music without any motor training in the studio. It

should be noted that during the scan at T1, the participant heard the music for the first time and did not know the choreography (i.e., the participant did not know which specific motor movements went with the music), so the high level of activation might reflect the novelty of the task or difficulty in generating motor imagery. This pattern of a high activation in SMA will have to be examined in future studies since this was not observed in previous studies (Bar & DeSouza 2016). At T2 a decrease in SMA activity was observed, following eleven weeks of dance classes learning the choreography in the dance studio along with additional imagery practice with the music at home. This might indicate a reduction in the demands of generating imagery, since the dance choreography was now familiar but not fully learned. At T3 there was an increase in activation, followed by a decrease at T4 when subject DD now learned the choreography and this could be the process of chunking during learning representing a consolidation of the choreography in the studio (Olshansky et al. 2014; Bar & DeSouza 2016).

The right and left insula were activated across all timepoints, but only the right insula showed a significant overall change across time. Further evidence for a role of the insula in dance was found in a study of older adults (Rehfeld et al. 2008), in which dance training was associated with an increase in grey matter in various brain regions including the left insula, when compared to an active control group who practiced repetitive movements. In humans, the insula has connections with parts of the brain such as frontal, parietal, and temporal lobes; the cingulate gyrus, amygdala, brainstem, thalamus, and basal ganglia (Flynn et al. 1999). Multiple functions of the insula have been proposed, including sensorimotor processes such as body awareness, error awareness, feeling of knowing, attention to pain as well as representing the physiological condition of the body (Craig 2009). In addition, it has been proposed to be the interface between body awareness and movement (Tinas et al. 2018). In our data we show an asymmetry in

function between right and left insula, which may be due to the differences between ascending and descending connections that utilize different frequency bands depending on feedforward or feedback communication (Bastos et al. 2015) or anatomical connections (Rivier & Clarke 1997). The right insula is more activated with visual and auditory perception of emotional music (Petrini et al. 2011), rhythm (Lappe et al. 2013) and melody (Thaut et al. 2014), while the left insula is more activated by active listening (Mutscheler, et al. 2007) and strong beats (Grahn 2009). This functional distinction could explain why different patterns of modulation were found in right and left insula in the present study. The insula has also been suggested to act as a hub for connecting attentional control and memory related regions (Mayer 2007); thus, it is possible that the decrease in activation of the right insula in our study reflects reduced demands on attentional processing, emotion and/or memory replay.

As mentioned before, Calvo-Marino in 2005, showed no other significant activation in the brain of expert ballet dancers except the pre-motor area and related the cause to the familiarity of the dancers with the routine. Based on the patient DD's chart as a case study, the insula is activated highly in the first week, but it levels out during time. We can suggest that the insula is not activated significantly during visualizing the dance, because the participants have learned the routine after 34 weeks and didn't need to pay attention that much. Our participant's number is little thus, this research can be considered as a pilot study and many other factors can be counted in studying this subject.

Moving to music involves a very complex set of activities that include complex neural networks throughout the brain. Brown states:

> The superior temporal gyrus and superior temporal pole represent the melodic and harmonic aspects of the heard music. In parallel, the medial geniculate nucleus appears to send inputs, via brainstem relay nuclei, to the anterior cerebellar vermis and lobules V and VI regarding beat information, to support the entrainment of movement to a musical

> beat. The basal ganglia, and particularly the putamen, subserve the selection and organization of segments of action, especially for movements having strong predictability and regularity, such as metrically timed movements. The thalamus is involved in linking somatosensory and motor parameters and is particularly important for novel or non-metric rhythms. Somatotopic areas for the lower extremity in motor, premotor and supplementary motor area (SMA regions) encode parameters related to muscle group, contractile force, initial and final position, and movement direction. The SMA, cingulate motor area and possibly the cerebellum support interhemispheric coordination of the two limbs during cyclically repeated, bipedal motion. The right frontal operculum is involved in motor sequencing, while the right cingulate motor area processes aspects of movement intention and the allocation of motor resources. Finally, medial aspects of the superior parietal lobule subserve kinaesthetically mediated spatial guidance of leg movement during navigation in dance (Brown et al. 2006, 1161).

Cortico-basal ganglia loops also have a great role in movement, posture, and action selection. The basal ganglia (BG) have been an area of interest for researchers since many degenerative neurological disorders are related to this network. Substantia nigra pars compacta (SNc), a part of BG, is composed of dopaminergic neurons and the degeneration of SNc can alter the balance of the BG circuits. Thus, increasing the functional connectivity of this will help patients in minimizing the disturbance caused by the degeneration of these dopaminergic neurons (Li et al. 2015). Li (2015) showed the functional connectivity of the interaction between cortico-basal ganglia loops and precentral and postcentral gyri and putamen increases due to dancing. De Dreu and colleagues (2015) have written an opinion article about partnered dancing for people with PD. They mention that music, which is used for dance, alters the mood through release of biochemicals such as dopamine, endorphins, and endocannabinoids from different parts of the brain. The release of these hormones is triggered due to activation of specific parts of the brain such as amygdala, nucleus accumbens, hypothalamus, hippocampus and the insula (de Dreu et al. 2015). Levkov and DeSouza (2014) have studied 47 participants for evaluating the effects of dance on Parkinson's Disease. The rsEEG in people with Parkinson's is abnormal due to

improper thalamocortical network and disruption in striato-pallidal pathways. Dopamine helps the low alpha power of people with PD to get back to normal. Levkov (2014) mentions that the cerebral blood flow in some regions of the brain such as thalamus, pons and midbrain, the basal frontal cortex and the insula causes increase in resting alpha power shown in rsEEG. Dance causes activation in different parts of the brain of people and increase in low alpha power (Levkov 2014). Overall, the insula receives input from dopaminergic and serotonergic afferents (Gogolla 2017). The findings of our case study indicate the potential neural effects of dance for people with PD, through activation of multiple brain networks associated with movement, planning, imagery, auditory and emotional processing. Still, further study is necessary to better determine the role of the insula on dance and its healing properties in different neurodegenerative diseases.

Music, Dance, Insula and Empathy

Learning to dance, playing music, and listening to music have affective responses. In 2011, Lamm and colleagues studied nine fMRI images to evaluate the pain of 168 participants. The whole brain scan and region of interest (ROI) analysis were done to evaluate the somatosensory responses in primary and secondary somatosensory cortex (S1, S2) of the participants while experiencing pain through watching painful pictures or scenes. They concluded that AI is involved in empathy for pain. They showed that AI is more activated during empathy with pain of someone else and this network is clearly separated from the network of nociception which causes pain through mechanical, thermal, or chemical stimulation (Lamm et al. 2011). Zamorano (2014), studied 11 professionally trained musicians and determined that vAI is activated when experiencing pain. Engen et al. (2013) showed that empathy is not an

automatic response for everyone, and it depends on a series of factors such as the character of the person, object of empathy, and social aspects.

Gujing et al. (2019) studied the insular function due to empathy by studying the fMRI of 20 dancers, 21 musicians, and 24 controls. Gujing and his team (2019) concluded that training in music and dance can improve empathic abilities. rs-fMRI results showed higher functional connectivity between the left AI and left pro-central gyrus and right precentral gyrus in musicians than the dancers. Musicians also showed higher levels of connectivity between the basal ganglia and AI while dancers showed higher functional connectivity between posterior insula (PI) and MCC. On the one hand, PI is activated by somatosensory signals from limbic system (Friedman 1986), and contrarily, PI is related to pain and internal bodily state (Cauda 2011; Becker et al. 2018). Subjective pain and empathy for pain is processed in the same region, AI (Gujing 2019). Since the insular activity during dance and music training overlapped with empathic circuits, Gujing and colleagues (2019) concluded that there are relations between empathic scores and insular functional connectivity. Existence of a sensory motor – insula-frontal loop has been studied by other researchers such as Namkung (2017).

Damasio (1999) mentioned that the insula is responsible for feeling the emotions and Habibi (2014) concluded that the insula is associated with listening to pleasurable music (Habibi 2014). Koelsch (2006) stated that amygdala is associated with irregularity or unfamiliarity of music (Koelsch 2006), while Trost (2012) concluded that para-hippocampus is associated with dissonance and unpleasant music (Trost 2012). In contrast, Gogolla claimed that the insula is activated during experiencing both positive and negative emotions such as anger, sadness as well as joy and happiness (Gogolla 2017).

Zhang et al, (2019) studied the role of different parts of the insula on affect, while listening to emotional and non-emotional sounds. The study was done on 24 epilepsy patients through fMRI and iEEG with electrodes implanted in their intracranial. They also collected DTI data from 30 non-epileptic subjects as the control group. They found structural connections between amygdala and the anterior insula, which inferred a conclusion that anterior insula (AI) is a part of the emotional processing network, and selective to the stimuli but with a shorter latency than amygdala. However, this connection between AI and the amygdala is stronger in the right hemisphere (Zhang et al. 2019).

Gogolla (2017) mentions that the insula also sends a signal to frontal regions of the brain such as the anterior cingulate, the orbitofrontal, and the medial prefrontal cortices, which are responsible for executive functions. These regions, in turn, send signals back to the rewards centers such as nucleus accumbens and putamen (Gogolla 2017). Music has been known to activate the rewards centre. The reward center of the brain is located in mesolimbic dopamine pathway which connects nucleus accumbens (NAc) with ventral tegmental area (VTA) where dopamine is produced (Alberico 2015).

The insula is a very important part of the brain which is activated during a wide range of incidence such as experiencing pain, love, emotions, enjoyment of music, craving, and addiction. All together Damasio calls all of these, our self-awareness in present moment known as somatic marker hypothesis (Damasio 1996). Craig (2009) mentions that the insula is the cornerstone of our awareness and can be studied as our neural correlation to consciousness. He reviews many different papers and studies to date and concludes that the feeling of “I am” is related to the insula (Craig 2009). Craig (2009) further determines that there are different parts of the brain networks which become activated with introspection, empathy, perceptual decision making,

cognitive control and even time perception. However, the insula (and specially AI) is common in engagement in all these experiences even in the events that ACC, which is interconnected with the insula, is not activated. Craig (2009) believes that all these tasks engage the person's awareness thus, the insula can be responsible for awareness in human beings.

Steven Pinker states that music is not necessary for the survival of human beings and he considers music as the "auditory cheese-cake" which was necessary for speech to emerge through imitating sounds in nature. This happened at the dawn of language development (Pinker 1997). However, music involves a core of awareness and musicians themselves do not require proof for its importance in human life. Knowing that the human race could not survive without attention, introspection, time perception and perceptual decision making, allows scientists to show interest in the study of the insula which is activated by all these events.

Table 1. Summary Table

Year of Research	Researchers	Number of Participants	Description
Music Perception----------Emotions			
2007	Gosselin et al.	1	Amygdala (Confusion between scary music and peaceful).
2007	Mitteschiffthaler	53	Amygdala/ Hippocampus (R. Hippo: sad music. LI: neutral music)
2012	Trost et al.		Amygdala (dissonance).
Insula			
1999	Flynn et al.		Insula: AI, Mid I, PI
2009	Damasio et al.		Insula and Emotions
2012	Seeley et al.		RvAI has more VEN neurons than LvAI
2014	Udin		AI: dAI: higher levels of cognition control. vAI: affective process.
2014	Gogolla et al.		Insula: positive, negative and social emotions
Music and the Insula			
2004	Brown et al.		Insula: activated in comparing joyful music to resting.
2006	Koelsch et al.		Insula: activated in comparing pleasant music/ non-pleasant.

2012	Zaki et al.		AI: emotional responses.
2013	Nazemic et al.		LI: Unexpected sounds.
Listening to Music			
1999	Blood et al.		R. hemisphere is more activated during listening to music while experiencing emotions.
2007	Mutscheler	10	L.AI: active listening.
2009	Damasio		Insula: Pleasant music.
2009	Grahn et al.	35	LI: Strong beat. R. premotor cortex: Weak beat.
2009	Craig et al.		R.AI: arousal such as pain. L.AI: Feelings.
2011	Petrini et al.	16	R.AI: both visual and auditory perception of emotional music. L.AI: only sound of emotional music.
2013	Lappe et al.	10	R.I: Rhythm.
2013	Nazemic et al.		LI: Unexpected sounds.
2014	Thaut et al.	10	R.AI: Melody. PI: Tempo.
2016	Shodha et al.	37	Live music / recorded music.
Making Music			
2016	Beaty et al.		RI: Related to salience network in creativity.
2019	De Aquino et al.	42	AI: improvisation. More activated in non-musicians/ musicians.
Dance and the Insula			
2006	Oppenheimer		LI: Parasympathetic system (Bradycardia). RI: Sympathetic system.
2014	Levkov et al.	47	Insula: activation results to increase in alpha power in the brain.
2015	De Dreu et al.		Insula: activates with dance which results increase in Dopamine.
2017	Gogolla et al.		Insula: receives input form dopaminergic afferents.
2018	Rehfeld et al.	38	LI: increased gray matter with dance.
Music, Dance, Insula and Empathy			
2011	Lamm et al.	168	AI: Empathy for pain.
2014	Zammarano	11	vAI: Pain
2019	Gujing et al.	65	L.AI is more activated in musicians in empathy vs dancers.
2019	Zhang et al.	54	R.AI: emotional processing.

Chapter 3: Healing with Music: Ancient Cultures to New Age Spirituality

Pythagoras, Plato, and Aristotle

Pythagoras, one of the most influential people in the history of Western civilization is best known today for his geometrical theorem. However his efforts to answer great questions about the universe, man, nature of knowledge, etc. makes him a guru figure for many. The word "philosophy" was coined by him, and he introduced himself as philosophos meaning, a lover of wisdom (James 1993). The word "harmony" or "armonia" is of Pythagorean origin, and did not mean the sweet, pleasant sound between two notes, but referred to "the attunement of the strings to the intervals in the scale, and the pattern of the scale itself. It means that balance and order, not sweet pleasure, are the law of the world" (Koestler 1959, 29). Pythagoras is the inventor of western music theory. One of the best introductions is by Arthur Koestler which Jamie James mentions in his book as:

> The sixth-century scene evokes the image of an orchestra expectantly tuning up, each absorbed his own instrument only, deaf to the caterwauling of the others. Then there is a dramatic silence, the conductor enters the stage, raps three times with his baton, and harmony emerges from the chaos. The maestro is Pythagoras of Samos, whose influence on the ideas, and thereby on the destiny of the human race was probably greater than that of any single man before or after him (James 1993, 21).

Pythagoras's vision unified religion, science, mathematics, medicine, cosmology, spirit, mind, body, and music. His philosophy reminds us of a sphere, so homogenous that we do not know which side to start opening. But the simplest route to penetrate this sphere is through music. It must be acknowledged that nothing survived from Pythagoras directly and everything known is through his students. Western humanists know that Pythagoras was born on the island of Samos in the sixth century B.C. and traveled to Egypt, Persia, and Mesopotamia. He learned geometry from the Egyptians, astronomy from Chaldeans, and philosophy of life from Zoroaster.

At the end of his life, he was involved in politics and was banished from Croton, Italy where he had established his academy around 530 BCE. Although the cause of the master's death remains unknown, it is widely speculated that fire may have played a role. His disciples especially Lysis, Archippus, and Philolaus had a great role in continuing the master's teachings and keeping it alive until it became the basis for Platonism. Pythagorean philosophy believed in duality and had a table of ten opposites as, limited vs. unlimited; odd vs. even; one vs. many; right vs. left; male vs. female; rest vs. motion; straight vs. curved; light vs. dark; good vs., bad; square vs. oblong (James 1996). He expressed these dualities with numbers and made a tetractys with them as a symbol of Pythagoreans. The progression symbolized the spiritual progress in the Brotherhood of Pythagorean School in the tetractys. Pythagoras also had another symbol with numbers named Gnomon, which is, in fact, the carpenter's rule. Aristotle explains how these principles were applied to music by Pythagoras as,

> The Pythagoreans, as they are called, devoted themselves to mathematics; they were the first to advance this study, and having been brought up in it, they thought its principles were principles of all things. Since of these principles numbers are by nature the first, and in numbers, they seem to see many resemblances to the things that exist and come into being; … since, again they say that the attributes and ratios of the musical scales were expressible in numbers; since, then, all other things seemed in their whole nature to be modeled after numbers, and numbers seemed to be the first things in the whole of nature, they supposed the elements of all things and the whole heaven to be a musical scale and a number (James 1993, 30).

In Pythagorean philosophy, music was related to numbers and the cosmos was music. Pythagoras introduced three kinds of music: Musica Instrumentalis which was the ordinary music made by lyre or pipe, etc, Musica Humana which was the unheard music of each human's body related to the resonance between soul and body, Musica Mundana which was the music of

cosmos or the music of the spheres. Since all three kinds of music were of the same essence, Pythagoras suggested music as a remedy for all diseases (James 1993).

Pythagoras found the arithmetical relationship between the harmonic intervals. It happened when Pythagoras was passing a brazier's shop. He noticed that different hammers produce different harmonious sounds when striking the same metal. He established that the musical intervals produced by the hammers were related to the exact ratio between the weight of the hammers. For example, a six-pound hammer and a twelve-pound hammer would make a perfect octave. Before Pythagoras, the explanation of the cosmos was more of a poetic form, but Pythagoras related that to mathematics together with music. He imagined the cosmos as a vast lyre with the crystal spheres in the place of strings. Based on Aristotle in his treatise, *On the Heavens,* Pythagoras believed that the motion of the planets should make a sound. He stated that the planets rotational speed, as measured by their distances, are in the same ratio as musical concordances. In this case, the sound of the circular motion of the planets is a harmony. This logic became unchanged for two thousand years. Pythagoras was the first one who suggested the Earth as one sphere as well as other planets. Pythagoras explains, counting outward; from the Earth to the Moon, is a whole step; Moon to Mercury, is a half a step; Mercury to Venus, is a half a step; Venus to the Sun is a minor third; The Sun to Mars, is a whole step; Mars to Jupiter is a half a step; Jupiter to Saturn is a half a step; Saturn to the sphere of the fixed starts is another minor third. Thus, the Pythagorean scale is C, D, Eb, E, G, A, Bb, B, D. Although this includes of 14 semi tones and 14 is not a favorable number among Pythagoreans, Aristotle explains that this sound is in our ears since our birth, but we cannot hear it, same as a coppersmith cannot hear the sound in his shop. Only Pythagoras could hear this sound (James 1993).

Following Pythagoras, Socrates in the 4th BCE, was the first one who built an academy which can be considered the first Western University. One of Socrates's disciples named Damon, was the first one who did research on the effects of music on emotions. He wrote an essay and handed it to the Council of Aeropagus on different musical modes and their effects on ethical behaviours and explained the importance for the government to supervise the music which is played among the people in order to measure the public health.

> Damon went into technical detail, describing six different modal scales, specifying the notes and intervals in each and pronouncing on their ethical qualities. He did the same with rhythms and tempi, commending some and condemning others on the ground that they expressed aggression, frenzy, or other undesirable qualities (West 1992, 246).

Plato, under the influence of Damon's ideas, believed that scales, rhythms, and dance have ethical qualities because they represent the voices and movements of the people. These qualities which are encoded in people will transmit generation by generation to younger people hence, it is very important in education to use the right kind of music. Plato approves only two modes introduced by Damon: the Phrygian and the Dorian (West 2000). He mentions that Mixolydian and hyper Lydian modes are useless while the Ionian modes and specific Lydian modes are relaxing and tranquil; thus, young people should avoid these modes. Only Phrygian modes and Dorian modes are allowed. Phrygian mode creates obedience to laws and moderation in living, while the Dorian mode helps warriors to accept and cope with their situation (James 1996). Interestingly, one night Pythagoras found out about a jealous drunk boy who was triggered by a song in Phrygian mode and wanted to set a rival's house on fire because of a woman. Pythagoras ordered a change of mode for the song and turned the mood of the boy to a calmer state (Zieman 1997). The modes (and their effects) employed by the Greeks were different than the medieval church modes which are common today.

Plato, in his book *Timaeus*, writes:

> Attunement (άρμονία), having motions akin to the circuits in our soul, has been given by the Muses to the intelligent user of the arts not for mindless pleasure, as it is fashionable to assume, but as an aid to bringing our soul-circuit, when it has got out of tune, into order and harmony with itself. And rhythm likewise, in view of the unmeasured and graceless condition that comes about in most of us, bestowed by them for the same purpose (West 2000, 58).

It was not the ethics of people which Plato was concerned about; Plato was very interested in the healing effects of music. In *The Republic* he states "music is most sovereign because rhythm and harmony find their way to the inmost soul and take strongest hold upon it, imparting grace if one is tightly trained" (Conrad 2010, 1980). Plato believed that mystic music can heal and purify the soul and slowly builds up the person's psyche. Since healing the psyche heals the body, through specific music, diseases can be healed. For example, the alternating sound of a flute and harp were applied to cure gout (Ibid 2010). Plato believed that sound travels in a circular motion. It is delivered by air in human's brain and blood through the ears, passed on to the soul and its ending in the liver leads to hearing. For example, the sound made by plucking a string on a lyre transmits air by passing on the shock to its neighbor in the blood and this movement sets up a circular motion and continues until the transmission stops. The sounds are harmonious to our ears when this circular motion is in correspondence with us (as Plato says, is in likeness with us) otherwise it will be a dissonance. Cornford explains the correspondence of the internal motion as follows.

> This we shall now understand as meaning that the succession of shocks in brain and blood set up by a rapid sound outside must correspond with the shocks set up later by a slower sound. 'Correspond' evidently cannot mean that the rates are the same, for that would result in unison, not concord. The correspondence meant can only be analogous to that of the vibrations of two strings, one of which vibrates (say) twice as rapidly as the

> other, so that each longer vibration coincides with every other shorter vibration and produces the concord of the octave (Cornford 1935, 324).

The concept of consonance and dissonance was very important to Plato in regard to health and he was obsessed with spiritual effects of different modes. One of Plato's disciples named Xenocrates of Chalcedon, head of the Academy from 339-314, practiced musical therapy.It is documented by Martianus Capella, that Xenocrates used to heal hysteria with music (West 2000). It has been insisted that he would use music without words, and this confirms the healing effects of music itself. In the ancient Greece, two instruments were popular: Lyre and Aulos. Aulos was a reed instrument very similar to oboe. It would normally be played in pair by one person. The player would play each aulos by one hand while both were in his mouth. Dorian mode was played with lyre and Phrygian mode was played with aulos. Pythagoreans used to play lyre and used it for calming. They considered aulos unpleasant and impolite, and recommended the students to wash their ears after hearing aulos although it was used by Ismenias from Thebes, to cure physical problems such as sciatica in 400 BC (West 2000).

Aristotle in 200 BC, influenced by Pythagoras and Plato, introduced four aims for music: music for pleasure, music for invoking emotions, forming morality, improving the intellect (Nazzaro 1978). Aristotle identified different modes as: Mixolydian would cause sorrow, Ionian and Lydian brought relaxation, Dorian could moderate the state of mind, Phrygian caused fire and inspiration (Aristotle, trans. Bywater 1946). Thus, each mode was used in a different situation. For example, Lydian mode could be used for relaxing the pain. Aristotle divided the melodies into three types: demonstrating character, arousing, and motivating. Rhythm would match with these types of mode and melody (Byers 2012).

Instrumental musical therapy continued in the West based on the same principles and fundamentals followed by Plato but little by little scientists started ignoring the effects of music especially on physical ailments. Musical therapy was considered fringe medicine and was used by a few doctors in mental illnesses (West 2000). During the Middle Ages in the West, Boethius's book, *De Institutione Musica* written in the sixth century became a point of interest and once again brought Pythagoras and Plato's musical theories in healing into life (West 2000). Boethius gathered all the Pythagorean-Platonic knowledge about musical therapy for both the physical body and the soul, and his book remained in the educational syllabus for medicine until the nineteenth century (Caldwell 1986). Although as Horden mentions, Boethius' music therapy in the Middle Ages was not the only method for healing, it was a complementary tool and employed mostly as a background theory with general recommendations (Horden 2000). Madeline Cosman has gathered evidence that no surgery would be done in later Middle Ages without preparation with music therapy and diet (Cosman 1978). There are also many documents showing the use of music in healing, especially mental problems, throughout Europe until the nineteenth century. Dancing mania has been reported since the Middle Ages. A famous example of music therapy is healing "tarantism." One of the first accounts documented is in 1021 at Kolbigk, Germany (Backman 1952). It was said that people were bitten by tarantula and in order to heal they had to dance from sunrise until noon, they would sweat, bathe and sleep and resume dancing until evening when they sweated, ate light dinner, and slept until the next sunrise. This ritual dance would continue for four or five days until they fell on the ground and the tarantula would get out of their body (Russel 1979). According to Koelhoff Chronicle in 1499, many people had this disease. Although tarantism was a typical kind of hysteria which affected mostly women and it was a psychological stress-induced outburst (Bartholomew 1989). This kind of

dance is a discharge of conflicts from society's taboos and traditions. The victim would fall on the ground without any movement, and it seemed that she was dying. The musicians would play different kinds of music and rhythms until they would find the right one for that specific tarantella. The patient would stand up little by little and involuntary movements would occur by her. She would dance faster and faster until she would sweat and, in most cases, vomit. It was believed that the sweat caused the venom to get out of the system. Sanz mentions that even doctors in Spain in the nineteenth century believed that music therapy was the only way for healing Tarantism (Sanz 2000). Tarantism ritual continues even until today as a reaction to poverty and depression mostly among the women to let them have a moment of attention and care in Mediterranean societies especially in Italy (Gentilcore 2000).

Music therapy in the 19th Century

The nineteenth century or the Romantic era, revealed two sides for art and music which could be either be toxic or tonic. Many authors have documented the fact that the music of Franz Liszt (1811-1886) could drive people, especially women, crazy. They would either feel manic or melancholic (Kramer 2000). According to romantic author, Alexander Sternberg, the manic would turn outwards becoming mesmerized at Franz Liszt concerts and would bribe the waiters to drink the remaining tea in Liszt's cup or wait outside the concert hall to meet him after the concert, and the melancholic ones would turn inwards, not being able to leave the concert hall and needed help to exit the event (Sternberg 1856). Liszt's biography indicates that he was involved in music therapy (Farrington 2015). In the beginning of the nineteenth century, music therapy was mostly used in psychiatry in asylums in Europe. Alan Walker reports about the story of a sixty-year-old woman who had been a patient in Salpetriere asylum since her childhood. She

could not even talk but she could respond to music. Liszt was invited to play piano for her. It is reported that:

> The moment Liszt's finger touched the keyboard; the old woman's eyes became fixated on them. Gnawing her fists, she appeared to enter a highly charged state, and she vibrated to every chord stuck by the young musician. The passage he played produced a visible effect on her similar to that of an electrical discharge (Walker 1983).

In 1807 Peter Lichtenthal in his book *Der Musikalische Artz* assigned different psychological effects to each note of the scales. For example, he believed that C-sharp is related to innocence and B flat makes you unhappy (Chassemi 1965). Thus, a suitable composition with considering the patient's mental state can help psychological disorders. He believed in conscious listening to music with pleasure thus, sometimes he made his patients to make their own music (Horden 2000). At the same time of Lichtenthal, Peter Joseph Schneider published a three-volume book regarding music therapy called, *System einer Medizinischen Musik* in 1835. Unlike Lichtenthal who would recommend music therapy together with medical practice, Schneider introduced musical therapy as a specialty in medical training. Later on, Lichtenthal and Schenider's methods were applied in German asylum practice. German psychiatrists in the Illenau asylum, believed that the soul is a rhythmic entity called *Gemuth* and compared the mental disorders with arrythmia which could be taken back in balance through music (Kramer 1998). They would choose the music carefully for their patients. The preferred composer in Illenau was Mendelssohn (1809-1847). Charles Rosen writes that Mendelssohn's *Songs without Words* possess:

> a Mozartean grace without Mozart's dramatic power, a Schubertean lyricism without Schubert's intensity. If we could be satisfied today with a simple beauty that raises no questions and does not attempt to puzzle us, the short pieces would resume their old place

> in the concert repertoire. They charm but they neither provoke nor astonish. It is not true that they are insipid, but they might as well be (Rosen 1995, 581).

Music therapy was common all over the Europe in the early nineteenth century with different styles. In France, music was combined with bathing to form shock therapy. In 1831 French psychiatrist Wilhelm Horn reported on a French asylum where they had eight stone bathtubs showers and a sauna with a loud organ, large drum, and cymbals (Kramer 2000). In Britain, music as a therapy in psychiatry had a serious role. From 1879 to 1884, Edward Elgar, the English Romantic composer worked as the conductor in *County Lunatic* asylum. He wrote a number of dance pieces for patients in Powick, south of Worcester (Northrop Moor 1984). Another interesting composer is Hector Berlioz (1803-69) who originally studied medicine and dedicated his *Symphonie Fantastique* to the study of a mental disorder of the 'idee fixe' (Kramer 2000).

Studies on the effects of music on physiology started in the early 1800s. The first report on these studies is by Diogel in 1880 in Salpetriere Hospital in Paris. He used coated drums with amorphous carbon powder and a needle to measure blood pressure and pulse rate of the people. He had to hire musicians to play music for the patients so that he could measure the physiological responses. In his first published paper he showed that music can lower blood pressure, increases the cardiac output, and decreases heart rate, and in summary music activates the parasympathetic system (Meymandi 2009). Later on in America, Corning (1880) and in Russia, Tarchanoff (1846-1908) together with Dr. Alexander Borodin, a professor of medicine and chemistry and a musician replicated these experiments. Tarchanoff would record the vital functions of his patients while they were listening to music and published a paper in 1903 (Ibid 2009).

Fredrick Harford (1832-1906) an English composer at Westminster Abbey, known as the pioneer in music therapy, ran his own experiment on healing pain with music on a number of patients and published his first article in the *Lancet* and the *Magazine of Music* in 1891. His hypothesis was that music could alleviate pain and decrease anxiety; thus, music has sedative effects. He gathered a band and named it Guild of St. Cecilia and gave them his own composition to play in hospitals in London per request by doctors. The remarkable aspect of his plan was to employ the newly invented telephone to play music simultaneously for patients in different hospitals (Tyler 2000). Harfords' work was criticized by many scientists, but he continued his research and published all his findings even though some of them didn't have the positive result he assumed. For example, he tried music therapy on scarlet fever epidemic in 1892 and produced controversial results. Harford's work was not valued during his time, but all the aspects of music therapy can be found in his work:

> "1- Music has the power to affect patients on physical or emotional distress.
>
> 2- Music is effective as a form of treatment alongside medical intervention.
>
> 3- There needs to be cooperation between the medical and musical professionals.
>
> 4- Training is essential before undertaking the work.
>
> 5- The efficacy of the work must be established by systematic evaluation and the publication of research findings (Tyler 2000, 378).

20th Century Musicians and the Concept of Healing with Music

With the invention of the phonograph and gramophone the application of music in medicine increased. In the USA, Dr. Evan O Neil (1880-1930) employed a phonograph in his operating room to ease the psychological stress of the operation. This method was soon to be

used in dentistry, obstetrics, gynecology, and in children's operation rooms (Kane 1914). The twentieth century discipline began after World War I and II when community musicians would go to the veterans' hospitals to play music for the soldiers who were suffering mental or physical traumas (Miller 2011). The positive response of the veterans to music led the hospitals to hire musicians. Noticing the soothing effect of the music on the nervous system and the mood caused more attention to the benefits of music in American hospitals and this interest led to the establishment of professional training at different universities such as Columbia University in 1919 (Tyler 2000). The first music-therapy degree program in the world was founded at Michigan State University in 1944 (Miller 2011), and National Association of Music Therapy (NAMT) was founded in 1950 (Tyle 2000). NAMT' s approach to music therapy is more clinical where there is another association for music therapy in America called the American Association for Music Therapy (AAMT) with a more holistic approach. These two associations merged in 1998 as the American Music Therapy Association (AMTA) (Miller 2011). Healing with music has roots in ancient mysticism. The definition of holistic can be understood from Borgatta in the encyclopedia of sociology as:

> The allopathic paradigm comes from a tradition of viewing reality as the result of unbiased empirical discovery, while the holistic model - which includes the scientific reductionist tradition as a piece of entire picture- also includes social constructionist and symbolic interactionist stances. This emphasis on the importance of how people perceive and define their reality is perhaps most succinctly posited by W. I Thomas: If humans define situations as real, the situations are real in their consequences (Borgatta 1992, 2130).

In the twentieth century music was used as a healing method, either complementary or independent for many cases such as pain reduction, operating rooms, ADHD, Alzheimer's disease, Parkinson's disease, autism, and palliative care. Many musicians alongside with other

scientists became interested in the effects of music on the brain. Paul Nordoff, an accomplished pianist, and composer, graduated from Juilliard, was a tenured professor at Bard College. He started using music for healing first in England and later in America, with Dr. Clive Robbins, a special education teacher, in daycares on disabled, autistic, and psychotic children in 1960. They expanded their work in Europe and Australia throughout the century. Nordoff-Robbins's method is based on improvisation and creative music and is still being used to date (Kim 2004).

The invention of neuroimaging and new techniques for brain mapping in the late twentieth century took the research on the effects of music on the brain to another level. Scientists such as Michael Thaut have studied the music and rhythmic entrainment and its effects on gait problems due to stroke (Thaut, 1995), Parkinson's disease (Miller and Thaut 1996), cerebral palsy (Thaut 1998), and brain injuries (Thaut 2005). Michael Thaut mentions that:

> 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 (Thaut 2005, 304).

Although research in music therapy was moving more towards clinical and scientific methods, a rapid transformation and a paradigm shift has taken place today in conjunction with ancient knowledge of music therapy and modern scientific methods which are applied by both musicians and scientists together.

New Age Spirituality and Music for Healing

The origin of new age spirituality is not fully known. We can assume its existence since the seventeenth century when Freemasonry and Rosicrucianism were founded. At the end of nineteenth century, Helena Blavatsky, cofounder of the Theosophical Society announced the new age concept (Melton 2016). Madam Blavatsky, lived in India for six years, and sought to merge religion, philosophy, and science when she brought Eastern esoterism to the West. She was very much under the influence of Buddhism (Wills 2016). Blavatsky met Koot Hoomi (1868), a master mahatma who lived in Himalayas. Master Koot Hoomi (Kuthumi), the inspiration for Blavatsky in introducing Theosophy to the world, believed that he was the incarnation of Pythagoras in one of his former lives. He is believed to be the guardian of wisdom who is concerned with culture, art, religion and education (encyclopedia.com). Master Kuthumi called music, "the most divine and spiritual of arts" (Barker 1962, 264). Garry Lachman in Blavatsky's biography (2012) wrote that she was a concert pianist who had performed with Clara Schumann. Among nineteenth century musicians, Alexander Scriabin was very much interested in Blavatsky's theosophy. His *Prometheus, The Poem of Fire* reflects the stanza of Dzyan, part of the secret book with Tibetan origin, which provides the basis for Blavatsky's book, *The Secret Doctrine*. Also in France, theosophy was linked to the occultist atmosphere of the *fin de siècle* period, and the music of Erik Satie, and the symbolist opera of Maurice Maeterlinck and Claude Debussy, *Pelléas et Mélisande*. Nicholas Roerich, a follower of Madam Blavatsky, was the designer for Stravinsky's ballet, *Le Sacre du Printemps* and some believe that he might have been an influence on Stravinsky's *King of Stars*. Early in the century Arnold Schonberg (1874-1951), Alan Berg (1885-1935), and Anton Webern (1883-1945), were all under the influence of Oskar Adler, another theosophist. Gustav Mahler (1860-1911) and Jean Sibelius (1865-1957)

were members of the theosophical circle as well (Cranston 1993). Music was not overly articulated in theosophical teachings and any direct influence on musicians disappeared by 1920s. Although the philosophy of bringing peace and brotherhood to humanity remained an aspiration for musicians in the West. In 1920 with the immigration of Paramahamsa Yogananda from India to the USA, and the founding of the Self Realisation Fellowship, New Age spirituality shifted towards inward practices such as meditation and Yoga practices in the West. New Age music since then became the reflection of the holistic ideology of New Age movement. (Weston 1999). Later, the peace movement of the 1960s and the growth of popular music inspired by Eastern spiritual philosophies established the new age music for achieving altered states of consciousness and peace of mind. One of the most famous influencers in the New Age movement, was the Harvard professor, Richard Alpert, known today as Ram Dass, who studied in India with Guru Karoli Baba (Button 1992).

Other musicians, such as John Cage (1912-1992), were influenced by Zen Buddhist teachings, while Karlheinz Stockhausen who used music as medicine, was under the influence of Sufism. Stockhausen's seven opera cycle, *Licht,* is a great example of the idea of the brotherhood. (https://www.theosophy.world/encyclopedia/music-theosophy-and)

Around the end of the twentieth century new age spirituality became very popular and the beginning of this new century was accompanied by the increasing demand for alternative and mystical solutions especially to counter the hectic mechanical life in the West. New Age movement combined the two concepts of monoism (All is One) and Pantheism (God is all, and All is God), thus, the followers could use different practices from different religions and indigenous people without any conflict in their belief systems. The ultimate Truth is one. People were also drawn to ancient techniques such as meditation, yoga, and naturopathic medicine in the

West. New Age spirituality is a movement that explains the ancient methods in a simple way that is understandable for all people. Before, mysticism belonged to elite or the chosen ones and it would also take years to be able to achieve higher levels of a guru's knowledge. At the end of the century through the miracle tool of the internet, everybody could easily access ancient knowledge and better understand that music was not only an agent for entertainment, but it could be widely used for emotional, physical, spiritual healing and for achieving personal transformation through meditation.

Musicologists claim that Tony Scott produced the first "new age" music album (1964), which was written for Zen meditation. Scott (born Anthony Joseph Sciacca, 1921-2007) played clarinet and studied classical music at the Julliard School of Music. He spent six years in Asia and India which led him to produce a new musical style which was classified as new age – a tranquil, soothing music for relaxation and meditation (Lange 2009). The *Yoga Meditation and Other Joys* album combined sitar with clarinet, a unique instrumentation at the time. The sitar player, Collin Walcott, had studied under Ravi Shankar (1920-2012) and had a major role in bringing sitar into jazz (https://poundforpound.me/music/2015/11/3/tony-scott-music-for-yoga-meditation-and-other-joys). In 1976, Windham Hill records in California started releasing new age music into record stores and in 1987, the Grammy Awards added the category for best new age album. Also in 1987, Suzanne Doucet organized an international new age music conference in Los Angeles, California (https://www.masterclass.com/articles/new-age-music-guide#new-age-music-vs-ambient-music-whats-the-difference).

The American John Cage approached meditation in a different way. One of his most famous performances was his silence concert in 1952. His piece, entitled *4'33"* consisted of three movements of silence and was composed for any instrument. The score instructed the

performers to not play their instrument for four minutes and thirty-three seconds. Cage was influenced by both Buddhism and Zen philosophy as early as the 1940's (Halpern 1985).

Steven Halpern, a trumpet and guitar player with a master's degree in the psychology of music from New York University, is known as one of the fathers of new age music. He won the crystal award at the first international new age music conference and in 2013 was nominated for a Grammy award for his new age album *Deep Alpha*. Halpern believes in healing the world through music.

One of the world's problems in twenty first century is sleep deprivation or poor quality of sleep (Chattu 2018). According to the National Heart, Lung, and Blood Institute of America, one third of Americans are sleep deprived. Sleep deprivation can cause physical and mental problems such as heart disease, kidney disease, high blood pressure, diabetes, stroke, depression, and obesity. (https://www.nhlbi.nih.gov/health/sleep-deprivation). In 2015, German born, British composer, Max Richter wrote a 250 page long song for 8-hour sleep. The music called *Sleep* consisted of 31 songs to be played by a string quintet, a piano, and a soprano. It was premiered live in the U.S. in March 2018 in Austin Texas and was played overnight in Manhattan, New York with 160 beds in May of the same year. Richter worked with David Eagleman, a neuroscientist from Stanford University to better understand the sounds and musical structures which lead to the deepest, non-REM sleep. Richter discovered that frequencies higher than 4000 HZ wake us up while frequencies up to 500 HZ can extend slow wave sleep even if they are loud. The music of *Sleep* is nothing but seven and half hours of sonic material pitched below1000 Hertz. Only the pitches with frequencies below the middle of the piano are sounded and these match the same frequencies that babies hear in the womb. The last hour higher frequencies are added to the music until it creates a "sunrise "(Corrigen 2018).

New Age spirituality proposes we are entering the Age of Aquarius (Sacredfire 2016), the era of expanded consciousness and of being mindful, where the old is meeting the new thus, the meaning and function of the music is changing more dramatically. Music is being used for altering the consciousness and supporting mindfulness. Humans are understanding the healing effects of music scientifically and are using music as a complementary healing process. Being alive in this era and observing this coalition is a blessing.

Chapter 4: Using your Body to Produce Music: Toning to Heal

Singing Music and Healing

Sound is the ultimate vibration. Sound is everywhere but only a part of it can be heard by the human auditory system. The greater part is within, not manifested, and beyond the conscious experience. Each body organ of living beings is vibrating at a specific frequency, which is known as health. Disease occurs when the vibration goes out of tune. It has been long believed by ancient cultures and indigenous tribes, that every living being has the ability to heal itself, to bring back the dissonance into harmony. Healing means increasing balance and integration of all the aspects of personality. The best tool, and the most available to human beings for this purpose, is their own voice. Our voice has the ability to create a wide range of frequencies to match the healthy frequency of our own body parts.

History of Toning as Healing

As mentioned, each body organ has its own resonant frequency. (Parkhurst 1998, 56). Together they make a harmonic composition, which is our personal vibratory rate. This composition can be seen through a Kirlian camera in color and is called aura. So we can imagine that our body is a wonderful orchestra playing a symphony while it is in a state of health. If an organ is vibrating at the wrong frequency, the whole orchestra will be affected. Ancient peoples believed that through the principles of resonance, sound could be used to bring back the out-of-tune organ. There is a principle about healing with music: Sometimes it is not about what we turn on, but also what we turn off. Sometimes healing is about letting go instead of getting from the music. (Stevens 2012, 7).

Sound for the purpose of healing has been known since ancient times. Healing with songs or the human voice goes back to Greek mythology when Orpheus and Apollo would heal people

with song. In ancient times in indigenous tribes, the medicine man would use music for healing. Curt Sachs traces back the effects of music in healing. He mentions, “Where the shaman performs religious ceremonies, the music approaches the liturgical intonation. And from the chants of the witch doctor, it has descended by a long chain of heredity to the liturgy of higher religion: it lives on in the Saman of Hindu as in the Leinen of Jews and the Lecito of the Christian churches” (Friedman 2013, 60).

David’s lyre served as a healing instrument for King Saul in the Old Testament. The music of David’s lyre had three effects on the sick king: It helped him find relief, made him feel better, and sent the evil spirit away from him. These three effects of music on King Saul demonstrate the effects of music on the mind, the body, and the metaphysical. (Friedman 2013, 58). These three aspects of music effects can be compared to the teachings of Ayurveda in Hinduism regarding the three layers of body that will be discussed later in this paper.

The medieval Jewish philosopher and physician in AD 12, Moses Maimonides, also healed the depressed Egyptian Sultan Al Malik Al Afdal by recommending an hour of singing performance for him accompanied by the lyre. The singer was ordered to gradually lower his voice after an hour and soften his melody until the Sultan fell asleep. The effect of singing for the Sultan maintained his mental and physical health. (Friedman 2013, 61).

Toning, or singing long notes for the purpose of healing, has been used all over the world throughout history. From ancient shamans to recent musicians, toning has been documented as a part of music with a different purpose than entertainment. The Tuve, in Mongolian tradition, sing special tones together with a Jew’s harp to heal and connect to the supernatural.

A.J.H Vincent found a Greek vase in a Berlin Museum in 1859 with the painting of four musicians: two playing cithara, and two playing double aulos. There are five vertical columns

beside them, with a series of characteristics that are archaic vowels: *A, E, I,* and *O* which Vincent interpreted as musical notations. In 1865, Gustav Friedrich Parthey, a renowned philologist, published the contents of two Greco-Coptic magical papyri with vowels on them dating 4-7 BCE. In 1887, Conrad Leemans, a German Egyptologist, published the great Leiden magical papyrus, which was full of vowel sequences. Charles Emile Ruelle, a French philologist, gathered a group of scholars to transcribe the Leiden into modern musical notation. It's interesting to know that his first collaborator, Adolphe Populus, died while working on that; and his successor, R. J Pottier didn't even live that long to start working on the notations. The work was done at last by Elie Poire, a librarian in Saint Genevieve library in Paris in 1900, and was published by international musicology congress (Godwin 1991, 41).

Sound affects our body in different ways. Scientists have proven that sound can make changes in circulation of blood, and the blood pressure would go up or down by stimulation of medulla oblongata. (Gordon, 1993). As Weeks Bradford states in his book, *The Physician, The Ear and Sacred Music*.

> We can understand the emotional impact of sound and its effect upon the body when we realize that the vagus nerve, which passes through the ear, extends into the larynx (the voice box) and all the internal organs including the entire intestinal tract, back muscles, lungs and heart. It carries the fibers that control the release of gastric and pancreatic secretions, and inhibitory fibers of the heart. (Gordon 1993, 81).

Dr. Alfred Tomatis, French physician, psychologist, and neurophysiologist explains.

> The joints, the muscles, in other words, the body's posture- everything we use to fight against gravity- all this is tied to the labyrinth of the ear. It is the ear's vestibular labyrinth that keeps all these under control, which is balance. To this mechanism alone I believe we can credit 60% of the cortical charge. You also have, thanks to the energy of the sounds themselves, which is processed by the cochlea, a complementary charge of about 30%. Thus, the ear accounts for from 90% to 95% of the body's total charge (Tim 1991, 41).

Studies have shown that sound can change our brainwaves. There are four kinds of brainwaves described for human beings: beta waves, from 14-20 hertz, which belongs to waking state; alpha waves, from 8-13 hertz, which belongs to meditation state; theta waves, from 4-7 hertz, which happens in deep mediation and sleep; and delta waves, from 0.5 to 3 hertz which can happen in deep sleep or profound states of meditation and healing. So, through sound we can change the brainwaves of a human being which can lead to the change of the state of consciousness or tuning each organ in its own frequency. (Goldman 2002, 15).

Dr. Tomatis shows the importance of sound in charging the brain by pointing out the stapedius muscle, which regulates one of the bones in the middle ear. This is the only muscle in the whole body that never rests. Even the heart muscle rests between each pulse. He believes that the frequency between 2,000 hertz-4,000 hertz is the best range for charging the brain. Thus, everybody can charge his or her brain by toning in this frequency range. (Gordon 1993, 81).

Different elements of sound have effects on different parts of the brain. Rhythm affects hindbrain, tempo affects the sense of time, and tone affects the limbic mid-brain which is responsible for emotions and is directly connected to the parts of the brain in control of heart rate, blood pressure, breathing, memory, stress levels and hormone balance. (Parkhurst 1998, 50).

Toning was described for the first time, by Elizabeth Keyes as human voice as a tool for healing in the academic world. John Beaulieu writes, “Toning is the process of making vocal sounds for the purpose of balance…. Toning sounds are sounds for expression and do not have a precise meaning” (Beaulieu 1987, 115). Beaulieu mentions that we naturally use toning for relief. He names a few such as yawning, moaning, screaming, groaning, and sighing. One does not need to be a musician to be able to do toning. These are the natural reflexes of the body that

everyone knows. In toning, there are no judgments, and no right or wrong. As Laurel Elizabeth Keyes, explains in her book *Toning*, "Toning is an escape valve for the pain because it is breaking up the tension which labels pain, and it brings new life energy to that place. It's an inner sonar massage." (Keyes 1973, 41)

Each tone is a sustained sound mostly a vowel sound on a specific pitch. Vowel sounds resonate in different areas of the body. The head cavity resonates with *I*. Throat and upper chest resonate with *E*. The chest cavity as well as the whole body resonates with *A*. The abdomen resonates with *O*, and pelvis and lower body resonate with *U* (Beaulieu 1987, 120).

Toning vowels was in its peak in the end of nineteenth century in the West. Richard Wagner employed wordless songs in "Valkyries" and the "Flower Maidens." Paul Napoleon Roinard, a French poet who lived in nineteenth and twentieth centuries, made a multimedia event named *Song of Songs*, subtitled as *Symphony of Spiritual Love*. It consisted of eight mystic symbols and three paraphrases with music. The recitation in the first one was dominated by the vowels *I* and *O* in D-major. The decorations were in orange color and the scent of violets was perfumed in the concert hall. (Godwin 1991, 51).

Edmond Bailey, an owner of a bookshop in Paris in the early twentieth century, collected as many songs of the vowels as he could find through history, and wrote his own song based on them. His *Chant des Voyelles* was written for women's voice, flute and harp. It was performed for the first time in 1906 at the Theosophical Society's Congress in Paris. (Godwin 1991, 51).

Later on, Alexander Scriabin, in 1910, brings the vowels: *E-A*, *O HO-A*, *O Ho*, in his *The Poem of Fire*. He has used these vowels based on the book of H. P. Blavatsky as, "The Root remains, The Light remains, The Curds remain, and still *OEAOHOO* is one". (Stanza 3:5).

Blavatsky explains that *OEAOHOO* is the symbol of the "septenary root" or "the six-in-one, from each all proceeds." (Godwin 1991, 52). https://youtu.be/AvjOkXXDty4

Toning in Hinduism

Toning requires deep breathing. Deep breathing provides more oxygen to the blood which leads to a healthier body and calmer mind. Breathing has been an important part of yogi practices for centuries. Chanting *seed mantras* which are mostly based on vowel sounds should be done with proper breathing and have been used for the purpose of healing in ancient India. In ancient Hindu philosophy each human being is made of three vibratory layers: the physical body, which functions during the waking state; the mental or emotional body which functions during the dream state; and causal or astral body which functions during deep sleep and profound meditation. (Frawley 1996, 308). Ayurveda, the healing branch of yogic science, believes that disease starts in the astral level which is the subtlest field around the body. If the person is not aware of the changes in this resonance, the disease expands to the mental body and forces this frequency field out of its tune. Still, if the person remains ignorant, the disharmony will affect the physical body. This is the reason that the yogis chant mantras every day in order to keep the whole astral body in tune before it affects the other layers. Ayurveda works with the concept of chakras. In recent years, universities such as UCLA and MIT have done research in the relationship between chakras and endocrine glands. (Gardner 1990, 1). The word "*chakra*" means "wheel" in Sanskrit. These are the points of the meridians along our body where the electrical pulses join together through the nervous system. There are seven major chakras located in the spine. Medical scientists relate chakras to plexuses in the spine. The plexuses belong to the anatomical nervous system and work together with glands on a psycho-physiological level. Chakras belong to the subtle body and are located exactly at the same points of plexuses in the

gross body. (Iyengar 2012, 162). Seven major chakras are: Root chakra, located at the sacrum or the base of the spine, called *muladhara*, associated with the adrenal glands; sacral chakra, located in lower abdomen, called *svadhishtana*, associated with the ovaries and testes; solar plexus chakra, located around the belly button, called *manipura*, associated with the pancreas; heart chakra, located at the center of the chest, called *anahata*, associated with the thymus gland; throat chakra, located at the base of the neck, called *vishudha*, associated with the thyroid and para-thyroid; third eye chakra, located between the eye brows, called *ajna*, associated with the pituitary gland; and crown chakra, located at the top of the head, called *sahasrara*, associated with the pineal gland (https://jothishi.com/chakras-and-planets/).

Each chakra has a specific frequency that can be tuned by a specific tone. Sanskrit is a sacred language. Each letter and each word have a special meaning. Every letter resonates with a specific emotion or body part. Thus, chanting each letter with specific rhythm or meter has a precise effect on a body part. I must mention that by each toning there should be a specific *mudra* in order to build the correct circuit for guiding the frequency to the necessary part. *Mudras* are the connection between fingertips, hands, and body.

In Ayurveda the sound of each chakra resonates with the frequency of the following sounds: root chakra, LAM; sacral chakra, VAM; solar plexus, RAM; heart chakra, YAM; throat chakra, HAM; Third eye, OM. The sound of the crown chakra is *OM* as “all sound”. It cannot be chanted loud, and it is an inner sound. By toning each of these one-syllable words, one can tune each chakra (http://ar-yoga.com). In traditional Hatha Yoga, the seven cleansing *bija* mantras associated with the chakras are:

Figure 4.Bija Mantras associated with Chakras.

"LAM"- chakra 1 (root)
"VAM"- chakra 2 (sacral/navel)
"RAM"- chakra 3 (solar plexus)
"YAM"- chakra 4 (heart)
"HAM"- chakra 5 (throat)
"OM"- chakra 6 (third eye/brow)
"OM"- chakra 7 (crown) (http://ar-yoga.com)

Based on *vedic astrology*, each chakra is related to a planet:

Root chakra is related to Saturn; sacral chakra is related to Jupiter; naval chakra is related to Mars; heart chakra is related to Venus; throat chakra is related to Mercury;

third eye chakra is related to the Moon (https://jothishi.com/chakras-and-planets/).

Most Chanted Vowels for Toning in Hinduism

Westerners know *OM* as an Indian ancient chant, but the correct pronunciation of this seed or *Bija* mantra is *AUM*. There are four books of sacred knowledge or *Veda* in Hinduism: Rg Veda, Yajur Veda, Sama Veda and Atharvana Veda. Each of these Vedas has three parts: Mantra, Brahmana, and Upanishad. Mantras are songs or chants upon glories of nature.

Brahmana includes detailed prescriptions for rituals. The Upanishads are about the philosophical aspects of subjects that the seekers are concerned about. There are 183 known Upanishads with ten being the most important ones. Mandukya Upanishad is one of them that explains the *AUM* in detail. Based on the Mandukya Upanishad, *A* represents the gross body and the waking state. *U* (as OO) represents the mental body or dream state. *M* represents astral body or deep sleep state. (Chinmayananda 2011, 21). By chanting each of these letters, we can tune in the associated body layer. If there is a disease in physical body, one can tone *A*. If there is a mental problem or emotional problem, one can tone *OO*. And whenever someone desires to access the higher level of consciousness, he or she can tone *M*. By chanting *AUM*, one can achieve tuning in all three layers of the body. The three phases of *AUM* are the representative of past, present, and future. They are also the representative of the three worlds: earth, atmosphere and the heavens. *AUM* integrates all human speech, and that is the reason why *AUM* is used in meditation especially in yoga philosophy. The meaning of the word, "yoga" is unity. *Manatryoga* means the sacred union between outer life and the deeper life. Yoga observes the life as a breath, which should go outwards as well as inwards and the same pattern is seen everywhere and in everything such as sunrise and sunset. The vibrations of each person's body are different during the day and night. Science has now proved that different hormones in the body activates in different times of the day or night. Yogis learned to regulate the rhythm of the blood circulation, the heart, and the different parts of the brain related to different hormones, through breath and audible vibrations. These sounds are called *mantras.* (Khan 1996, 51). *AUM* is believed to be a cosmic sound. *AUM* leads the human beings towards liberation. Maitri Upanishad explains, "The body is a bow. The arrow is AUM. The mind is its point. Darkness is the mark." (Rowell 1992, 38).

The fact of morphogenetic plays a big role here. People should chant the word correctly in order to have the correct attunement. Toning *OM* has a different effect than *AUM*. Lewis Rowell in his book, *Music and Musical Thought in Early India*, emphasizes on the human nature of the Indian concept of sound. He mentions that vocal sound is the primary model for all musical sounds. He explains, "the primary connection between the universal substratum of sound and the individual musical sounds is by way of human vital breath (*Prana*)" (Rowell 1992, 40).

Toning and its Effect on Different Body Parts

Another important thing to acknowledge is the frequency of each body organ related to each chakra. Dr. Valerie Hunt, a scientist at UCLA, has calculated the frequency of each chakra as sinusoidal electrical oscillations. She has also compared the frequency of each chakra to the resonance of the colors with the help of EMG electrode reading. (Parkhurst 1998, 31). Barbara Hero, a mathematician and musician, the inventor of Lambdoma, an electronic instrument based on Pythagorean table, has calculated the frequency of each chakra as below:

Table 2. Chakra energy centers of our bodies

CHAKRA	**FREQUENCY/MUSICAL NOTE**
CROWN	480 (15:1) B
THIRD EYE	448 (14:1) A
THROAT	384 (12:1) G
HEART	341(1:12) F
SOLAR PLEXUS	320 (10:1) Eb
SACRAL	315 (1:13) D#
ROOT	256 (1:1) C

Based on the frequency of each chakra, one can tone *A* or *AUM* in any of the frequencies mentioned above. If the intention is opening the heart, *AUM* can be chanted in a range close to 341 hertz. If the intention is opening the third eye, *AUM* should be chanted in a range of 448 hertz. The intention plays a great role here. Jonathan Goldman, musician, and director of Sound Healers Association, explains that chanting by yourself has more powerful healing effects than listening to music because you can put your intention on the area that needs healing. https://youtu.be/SBiwLibZqfw

Tibetan monks use Tibetan bowls to create the frequencies for each chakra instead of toning. The advantage of these bowls is their accuracy in the frequency range. People may need a tuning fork to tune in the correct frequency to start their toning. https://youtu.be/ZxHyKtgjmAM

Toning in Sufism

Toning plays a big role in the tradition of Sufism. Sufism is another mystical path that arose from East, specifically from Iran. Sufi disciples are called Dervishes. The origin of Sufism goes back to Rumi, an Iranian poet from thirteenth century. The master in Sufi tradition, *Pir*, is a descendant of Prophet Mohammad but Sufism is all about the spiritual aspects of humans and God. Many other poets have joined the path of Sufism after Rumi. The teachings of Sufism are all through mystical poems. There is a poem by Hafiz, a Persian poet from fourteenth century, that says the soul refused God's command to enter the body of a human being because it was made of clay, and the soul would think of it as a prison. So, the angels started to sing, and the soul entered the body. (Khan 1996, 17). This is also mentioned in the Bible, that it was first the Word and then came light. The first verse that Prophet Mohammad channeled was a command from God, "Chant."

Sufis use *zikr* for chanting. Inayat Khan mentions in his book, *The Mysticism of Sound and Music*,

> (The) secret of the whole phenomenon is that by power of words they try to tune their body to the pitch of vibration where no fire, no cut, nothing can touch it. Because the vibrations of their body are equal to those of the fire, therefore the fire has no effect (Khan 1996, 78).

https://youtu.be/zg2OW5wnRF0

The three basic sounds used by the Sufis in their chants are *A, I* (as in machine), *UOO*. In The Book of Sufi Healing, Shaykh Hakim Abu Abdullah Moinuddin writes,

> The three sounds are long vowels of A, I, U. These are what the Sufis call the universal harmonic constants and they are used in all mystic paths that utilize sounds…The long vowel sound of A as in father, as a vibratory tone, travels downward and slightly to the left from the throat and centers in the heart…The long sound of I, as in machine, moves in the opposite direction, up the nasal septum, and vibrates at the point of the pineal gland…The long sound of U, exists when uttered exactly at the point on the pursed lips, the point of connection between in- and out- breaths (Goldman 2002, 48).

Sarmad Brody, the author of *Healing and Music* explains that Hazrat Inayat Khan, the head of the Sufi Order of the West, insisted on toning the vowels so long to be able to hear their overtones. Inayat Khan has mentioned the vowels, *OO, A* and *EE*. His son, Pir Vilayat Khan associated these vowels to different chakras: *A* that resonates with heart chakra; *OO* that resonates with throat chakra; *EE* that resonates with third eye and crown chakra. (Goldman 2002, 49).

Most Chanted Vowels for Toning in Sufism

The two important Sufi chants that are the names of God, are *HOO* and *HAEE*. *HOO* means "that which is, that which was and that which will be". *HAEE* means "omnipresence". By toning these sounds, Sufi can enter an altered state of consciousness that enables him to purify his soul and become beyond the senses and cure his disease. Normally these tones are accompanied by stating the knowledge of divine truth as *la illaha illa 'llah*. The only true reality is shown when all else is gone.

https://youtu.be/-UEfxFJXql0?list=PLBAcMpa9tEtive3IWXWVj_s5ZOQx5dXIH

Comparison Between Toning in Hinduism and Sufism

Sufis believe that the whole life itself is a music. Music has a rhythm. There are three elements in rhythm: gentle or productive or progressive; active or supporting or controlling which is more productive than the first element thus can be considered sustaining; inactive or destructive or decay. This idea in Sufism matches the idea of *trimurti* or three aspects of God in Hinduism. They are named, Brahma, Vishnu, and Shiva. Brahma is the creator, Vishnu is the sustainer, and Shiva is the destroyer. In Sufism they refer to Holy Quran that says first the word was spoken and then all became manifested. Hinduism believes that from the world of sound,

there came the world of forms. Thus, the creator is the sound God or *Nada Brahma*. Based on both teachings, the key to the mystery of the existence is the knowledge of the sound (Khan 1996, 27). Sufis have not used the music for entertainment, but for purification. Sufis use *zikr* that is the same as mantra in Hinduism.

Both schools believe that by purifying the soul and becoming more connected to the Source, or God, one can be healed from diseases. Inayat Khan, in his book, *The Mysticism of Sound and Music*, explains,

> Even if music were not used as a prescription particularly intended for a certain illness, still the power of illness, which has its abode in the heart of the man, can be reduced by lifting up his heart, by changing his thought. What brings the illness is the thought of the illness rather than the illness itself. The existence of illness in the body may no doubt be called a shadow of the true illness which is held by man in his mind. By the power of the music the mind may become so exalted that it rises above the thought of the illness; then the illness is forgotten (Khan 1996, 106).

He insists that singing is the most powerful tool for healing because it is in direct touch of the heart. As mentioned by Jonathan Goldman, intention plays a big role in healing sounds.

I believe that toning is a part of the inner journey. The vowels are considered spiritual because the gods themselves often have names composed purely of vowels. The most famous example is the letters of *Tetragrammaton, iod-he-vau-he,* which is transliterated to *YHVH, YHWH, IEVE, IAHVE, HAYEE, YAHOO,* and so on. Elias Boctor, an Arab linguist, has mentioned that Hebrew alphabet has been derived from the Chaldeans and includes seven vowels: *aleph, heh, cheth* (represented by *e, h, ch*), *vav* with point *hirek* (represented by *ou, u, y*), *vav* with point *holem* (represented by *o*), *Iod* (represented by *o)* and *Ain* (represented by *ho, who)* (Godwin 1991, 57). Fabre d'Olivet, an expert in Hebrew language, has mentioned that *Ihoah* is

translated as “the Being who is, who was and who will be.” Adolphe Lethierry Barrois, who died in 1863, spent his life on the origin of human’s language. He writes in Hebrew primitif:

> The Hebrew letters are the ciphers of signs of zodiac, from which the words of Hebrew language itself are formed; the consonants are the letters or ciphers which assemble around the vowels to form the words, just as the constellations assemble around the Sun, image of divinity, and compose the community of stars over which it presides. The constellation of zodiac formed the twelve great Gods of Greco- Roman antiquity, corresponding to the twelve stations of the Sun and these constellations were distinguished by the letters from Aleph to Thau, attributes or energies of the same divinity, they are so speak the pearls which have formed the necklace of the Zodiac, and the vowels corresponding to the seven planets which surround the Sun are the voices which give sound or color to the consonants, they form the word and the word is the Divinity itself. The priests of Abydos would recite the mystic hymn of the seven vowels, or the name of Jehovah which unites them. It’s through the word or Son of God that all creation was made, for the voice and the vowel give life to consonants, just as the Sun gives color to bodies, to matter and the consonants or radical letters, animated by the vowels, form the roots that compose the primitive, mono syllabic language (Godwin 1991, 63).

An Example of a Western Composer who used toning for healing under the influence of both Hinduism and Sufism

Karl Heinz Stockhausen, a musician and composer, has used the vowels in his music as well. Stockhausen, the father of electronic music of the twentieth century, had an affinity with Yoga philosophy through Sri Arobindo, a Yoga philosopher in the West. He also got to know Pir Vilayat Khan, the head of the Sufi order in the West through Jill Purce, an English art historian. He established a close friendship with Khan and always gladly mentioned him as his favorite reading matter. (Kurtz 1992, 189). Khan mentioned in one of his interviews,

> I visited some time ago Stockhausen, who is a German composer… and he demonstrated at a meal his extraordinary skill in producing overtones. And he was able to produce something like 28 overtones as clear as bell. He said that he concentrates on a particular point in the brain above the palate for each overtone and that each overtone is placed higher up in an area within the brain. It occurred to me that you should be able to produce an overtone that is resonant with the specific resonance of the Pituitary for example. You set the Pituitary in action, which would immediately start secreting hormones which

> would have various effects. But you would have to know exactly what you are doing. It would be quite dangerous just to simply stir up the Pituitary without specifically knowing which hormone. Is it going to be the Growth hormone? Or is it going to be the Gonad hormone or what is it going to be? So, it's much more complex than that. But I'm just giving you an indication of the lines of the research that will hopefully be followed up on the next decade (Goldman 2002, 97).

Stockhausen was the first Western composer who created a music for overtone singers. It was named, *Stimmung.*

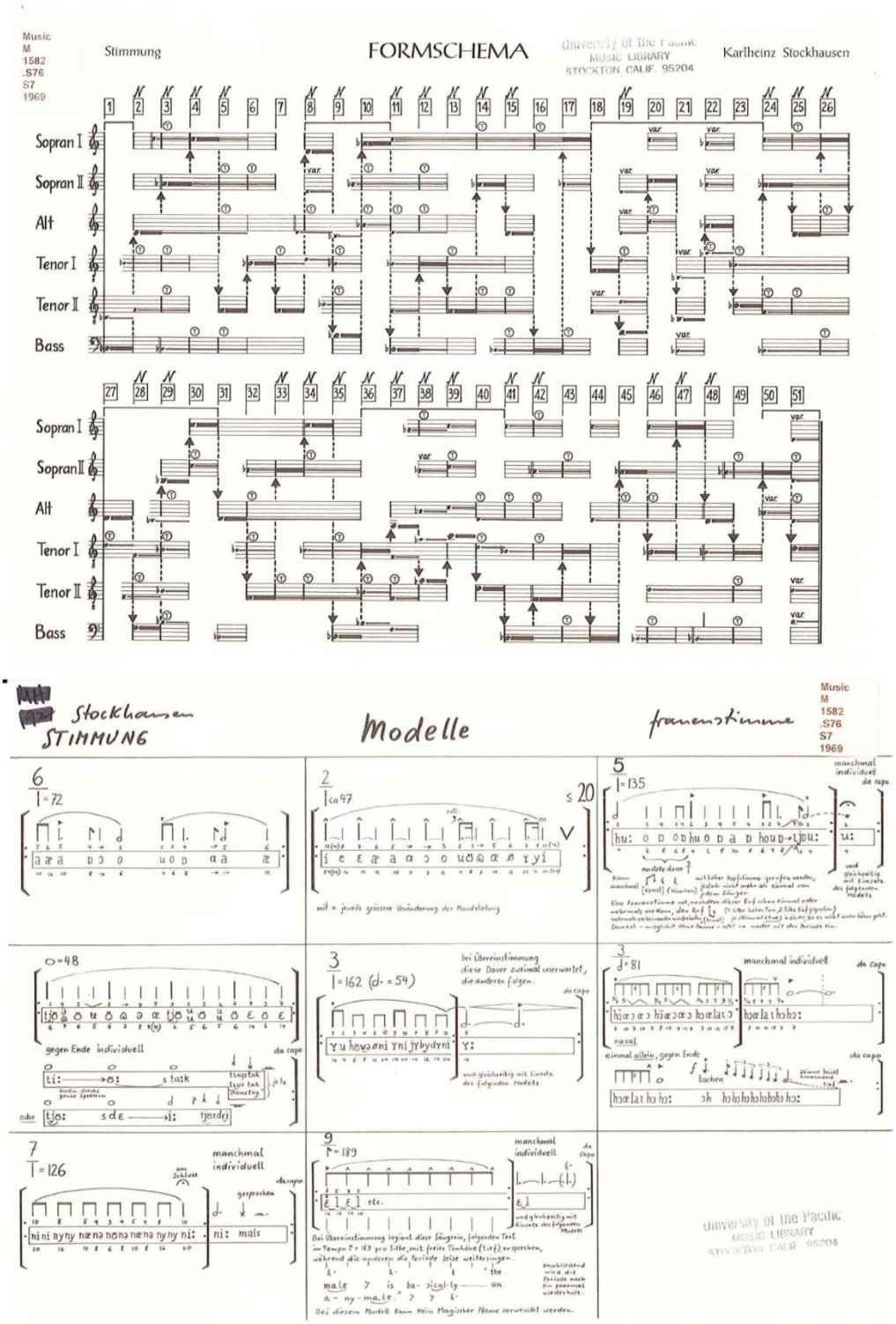

Figure 5. Stimmung

"Stimmung" has different meanings in German. One of its meanings is, "tuning". Stockhausen mentions that it can be the tuning of the soul. In German, when someone says, "we are in a good stimmung," it means they are in good psychological tune together. (Cott 1973, 162). Stockhausen has made the following comments about this music:

> You will hear my work Stimmung, which is nothing for seventy- five minutes but one chord- it never changes- with the partials of natural harmonics on a fundamental. The fundamental itself isn't there, the second, the third, fourth, fifth, seventh and ninth harmonics and nothing but that…The singers needed six months in order to learn precisely how to hit the ninth harmonic or the tenth, eleventh, thirteenth up to the twenty fourth… Its wonderful technique to learn because you become so conscious of the different parts of the skull which are vibrating. If you met the singers, you'd see how as human beings, they have changed. They'd completely transformed now that they've sung it more than a hundred times since the World's Fair in Osaka (Cott 1973, 38)

https://youtu.be/ty9G0asmZ_k

Stimmung was performed seventy–two times at Osaka World's Fair (1970). Stockhausen mentioned in his interview with Jonathan Cott that many people have thanked him for the experience they had during its performance. Stockhausen believed that they should thank themselves for letting themselves to be transported to a state they normally do not experience. He claimed that he had examined the effects of those overtones on his own mind before composing the music and mentioned that people should use sounds for specific purposes such as healing. Stockhausen was one of the musicians who believed in the sacred use of music as a vehicle to reach to the state of trance or meditation or ecstasy. He was completely against the attitude of using music as an acoustical tapestry (Cott 1973, 82).

Jill Purce, a student of Stockhausen, spent ten years in studying overtoning with Tibetan monks. Purce has worked with the department of bio physics of King's College University together with Moris Wilkins, who won a Nobel prize for discovering the DNA molecule. She has worked on sound vibrations on cells. Purce mentions in an interview with Jeffery Mishlove that

sound can healby *vibratoryhood*. She claims when we use the vibratory element in us which is the voice, we are able to tune the body with the mind. She calls the human being a wind instrument. She says that the voice is attached to the breath and the breath is attached to the subtler breath which is related to the thoughts. The cause of illness is mostly anxiety and negative thoughts. She mentions that 85 percent of illnesses are psychosomatic. Purce explains that we can enter into the cracks of thoughts with toning. We can enter to the nature of the mind which is beyond the chattering mind. This is the state of clarity, which can be called healing. She explains that when you chant a tone, the important thing is not the chant itself, but is the listening to the chant. You are making a circuited attention. You are making a sound, so you are the subject and you are listening to that sound, so you are at the same time the object. This is the time you become the creator and the created. By toning you have to stimulate parts of the brain and the nervous system that you normally don't use, and this should be done together with a very controlled breath. She mentions chanting *AUM* as a sacred ancient mantra and says that by chanting such an ancient mantra we attune into the attainment of the energy of all sages who have ever chanted it for centuries. This is the result of the study of Rupert Sheldrake in the *morphogenetic field*. The more people chant the same tone, the easier will it become for other people to attune in the same energy level. That is why we should not change anything in chanting the mantras. They should be as similar as possible to its original ritual to have the same effect. https://youtu.be/yoj6FAarThQ

Chapter 5: Using your Body to Produce Movements to Music: Dancing to Heal

Moving to music or dancing as an "orchestration of energy" is a very deep biochemical experience. Repetitive patterns such as diagonal or straight hand movements, hopping, displacement of the feet, cutting edges sharp and soft, and moving the gaze, all these movements constrict and dilate our blood vessels, fire millions of neurons, and produce a rush of neurotransmitters in the brain that induce many different sensations and emotions (Dils et al. 2001). As Joan Accocella in her essay "Imagining Dance" states,

> Dance is a language. Its logic is not discursive but lyric. Like music it's a force field, an orchestration of lines and force, lines of energy, and that is the only way to start understanding it. Dance is not a story; it is a song (Dils et al. 2001, 13).

Choreographer Mark Dendy states "Dance is a contemporary ritual and a spiritual opportunity to share energy, join in a sense of communitas" (Dils et al. 2001, xiii). Although dance as ritual has been a part of humanity since ancient times, reviewing the history of dance is chronologically impossible, and we can just study it topographically.

Dance does not belong to a specific group of people and its purpose is not only to create beauty for visual pleasure but to explore the beauty which already exists within an individual. Thus, to dance one does not require a perfect body shape or a specific physical condition. Ann Cooper, an English physiologist and author, has focused on dance with disability. Working with the Cleveland Ballet Dancing Wheels, she focused on the movements designed for limited standards of fitness. During her time at this institute as well as during her career she revolutionized the field of dance by replacing the stereotypical definition of dance being only an activity that portrays beauty. Her more conventional definition of dance focuses on gaining pleasure in movement through satisfying the specific needs of each dancer (Dils et al. 2001).

Dance can indulge the need for healing. It has been used as a healing component from ancient times and even today this “old” application is found among Shamans, Sufis, and other spiritual traditions worldwide. New age dance therapy was founded by Marian Chace in 1947 in St. Elizabeth’s Psychiatric Hospital in Washington D.C to help the casualties post World War II. (https://www.adta.org/marian-chace-biography).

Dance therapy is intertwined with music, due to the music’s role in foreshadowing the bodily movements of the dancer. Music therapy by itself has been an ancient tradition alongside dance therapy. In the Medieval era, women would dance to different kinds of music in order to get rid of the bite of tarantula from their bodies. It was not only the dance which was important but the music which could create the urge to move the body. The Tarantella dance was something beyond the bite of the tarantula, it was a metaphor for women’s mental crises in life at the time. This metaphor portrays music as the cure to this problem by allowing women to convey their emotions through bodily movements which would show anger, disgust, and despair (Siporin 2009). Music therapy can be applied on its own, but dance therapy cannot be separated from music. Music is the required component of dance.

Moving to Music and the Brain

Moving to music is a very complex set of activities that involves complex neural networks throughout the brain: “The superior temporal gyrus and superior temporal pole represent the melodic and harmonic aspects of the heard music. In parallel, the medial geniculate nucleus appears to send inputs, via brainstem relay nuclei, to the anterior cerebellar vermis and lobules V and VI regarding beat information, to support the entrainment of movement to a musical beat. The basal ganglia, and particularly the putamen, subserve the selection and organization of segments of action, especially for movements having strong predictability and

regularity, such as metrically timed movements. The thalamus is involved in linking somatosensory and motor parameters and is particularly important for novel or non-metric rhythms. Somatotopic areas for the lower extremity in motor, premotor and supplementary motor area (SMA regions) encode parameters related to muscle group, contractile force, initial and final position, and movement direction. The SMA, cingulate motor area and possibly the cerebellum support interhemispheric coordination of the two limbs during cyclically repeated, bipedal motion. The right frontal operculum is involved in motor sequencing, while the right cingulate motor area processes aspects of movement intention and the allocation of motor resources. Finally, medial aspects of the superior parietal lobule subserve kinaesthetically mediated spatial guidance of leg movement during navigation in dance" (Brown et al. 2015).

Cortico-basal ganglia loops have a great role in movement, posture, and action selection. Basal ganglia (BG) have been an area of interest for researchers since many diseases are related to this network of brain circuits such as Parkinson's, Huntington's, and Tourette's syndrome. Substantia nigra pars compacta (SNc), a part of BG is composed of dopaminergic neurons where their degeneration can affect the balance of the BG circuits. Thus, increasing the functional connectivity between this loop has a great impact on reducing the effects of disturbance due to degeneration of dopaminergic neurons (Li et al. 2015). Li showed the functional connectivity or the interaction between cortico-basal ganglia loops, and precentral and postcentral gyri and putamen increases due to dancing. (Li et al. 2015). Regarding posture and action selection, dance and any casual practice in coordination can improve balance and reduce the risk of falls (Cadore et al. 2013).

The function of the motor units in the spinal cord and myelin sheaths around ventral root fibers decrease with aging which leads to reduction in the gait, balance and motor functions (Lexell 1997). The concept of motor reserve has come in the spotlight for the researchers in the field of gerontology in recent years. In regard to this subject, Deborah Fleischman, (2015) has conducted a study on 167 adults with an average age of 80 who were participating in a longitudinal study for "Rush Memory and Aging Project". She concluded that physical activity could preserve the motor function against the effects of brain pathology due to old age (Anderson 2015). This is referred as "Motor Reserve" and is something necessary to act against the natural aging process and neurological disorders. One needs to consider the positive influence of moving to music on motor reserve in his or her life and implement a moving as a routine to prevent motor degeneration (Fleischman et al. 2015).

Besides all these areas in the brain which are involved in dancing, auditory cues have a great role as well. Beatriz Calvo-Merino, in 2005, studied the brain scans of ballet dancers and capoeira dancers by showing them a three second silent video. They found that the activity of pre-motor cortex only increased in the dancers who were familiar with their genre of dance (Calvo Merino 2005). Thus, we may conclude that music has a great impact on learning new movements and researchers who have conducted studies on the influence of dance on PD symptoms have mentioned the importance of auditory cues and its role in facilitating PD patients' movement. Out of 50 studies on rhythmic auditory cue, 88% have reported positive effects on gait in Parkinson's patients (Ghai 2018). The use of music in neurorehabilitation or Neurologic Music Therapy (NMT) has three components: Rhythmic Auditory Stimulation (RAS), Therapeutic Instrumental Music Performance (TIMP) and Pattern Sensory Enhancement (PSE) (Thaut 2005). RAS or Rhythmic Auditory Stimulation is a beneficial technique for

improvement of gait in PD. Ashoori (2015) has summarized a number of studies on the effects of RAS in improvement of the gait in PD patients who can walk better when they synchronize their footsteps with a musical rhythm. Earlier, Thaut and his colleagues, showed gait improvement in PD patients by playing familiar genres of music such as jazz, folk, classical and country for three weeks on 15 PD patients (Thaut 1996). Other researchers have also mentioned the importance of music as an auditory cue not only as RAS but also in combination with TIMP and PSE, in improvement of gait in people with PD. In one study, Postural stability and spatio-temporal gait of 55 people with PD were measured during listening to mp3 recorded Indian and African music for four weeks. Significant improvements were recorded for both gait and posture in patients with PD (Bukowska 2015).

What is Parkinson's Disease?

Parkinson's disease (PD) is a degenerative neurological disorder with no known cure. More than 10 million people have Parkinson's worldwide. In Canada, 100,000 people[2] suffer with PD. Based on the statistics of Parkinson's Foundation, each year about 60,000 Americans are diagnosed with the disease with this number expected to be circa 1,000,000 in 2020 in US alone. Although Parkinson's impacts the older adults, 4% of the people diagnosed in America are under 50. The direct and indirect costs of Parkinson's are estimated at $52 billion annually for US. Annual medication costs for PD averages USD 2500 per individual.[3]

The rising tide of people diagnosed with PD has a huge effect on society in terms of professional care givers and private care. Not only is the disease itself a major problem but caring for patients and ensuring a decent quality of life are also challenging. PD develops when

[2] https://www.ucbcanada.ca/en/Patients/Conditions/Parkinson-s-Disease
[3] https://www.nature.com/articles/s41531-018-0058-0

the nerve cells in the BG responsible for the production of dopamine (specifically Substantia Nigra within the BG) are reduced to a critical level where the balance of dopamine from these neurons are now not sufficient and it causes non motor and motor symptoms that make the patient seek out medical advice. Motor symptoms appear when more than 50% of the dopamine cells in SNc is lost which shows that dawn of the PD is many years before the appearance of its symptoms. Motor symptoms consist of tremors, bradykinesia, gait and balance problem and limb rigidity. The non-motor symptoms can be noticed before the appearance of motor symptoms with loss of olfaction, mood changes, anxiety, and REM-sleep behaviour disorder (MDS 2019). The reason for this damage of dopaminergic neurons is not yet known and the only way that conventional medicine can help these patients is medications (notably L-dopa) to decrease or mask the symptoms of degeneration. Other medications together with L-dopa may be used in order to keep the balance between dopamine and acetylcholine. The medication itself has many side effects on breathing, mood and movement. Sometimes Extrapyramidal side effects (EPS) can be seen in people with PD which resembles dyskinesia or motor dysfunction which is due to the wearing off from the medication not the disease itself.

Dance with Parkinson's Disease in the World

The bradykinesia appearing simultaneously together with gait problem in PD led to foundation of Movement Disorder Society (MDS) in 1985 by David Marsden and Stanley Fahn. Providing support for the latest research and diagnosis for people with Parkinson's was the main goal of this foundation. Clinicians and researchers such as Christopher Goetz and Stephanie Shaftman, have worked on designing a unified scaling rate for evaluation of non-motor and

motor function of people with PD. This scaling rate can be used all around the world together with other standard questionnaires in order to bring all studies in the same direction[4].

Over the past decade many scientists have studied the effects of dance on the symptoms of movement disorder in patients with PD. More than 1100 papers have been published in *PubMed* on this subject. Movement Disorder Society (MDS) has also reported improvements in the gait of dancing PD patients, using Unified Parkinson's Disease Rating scale (UPDRS) for data collection. UPDRS is an international evaluation test consisting of 4 parts. Normally researchers use some parts of this rating scale, but our team used all four parts every time. Part I, evaluates cognition and non-motor aspects of experiences of daily living, Part II, evaluates motor aspects of daily tasks including patients' clinical states as well as being on or off state on Parkinson's medications such as Levodopa. Part III evaluates motor abilities such as examining the rigidity of the hands, neck and legs plus evaluating the degree of tremor in different positions, gait and stability in standing position. Part IV consists of evaluation of motor complications such as dyskinesias, dystonia, and motor fluctuations. Part IV would be filled by the patient or the caregiver at home.

It all started with Argentinian tango (Hackney et al. 2007) and expanded to include Irish step dancing (Volpe et al. 2013), Mark Morris contemporary dance, ballet, contact improvisation and ballroom dancing (Hackney 2009). The first article published by Hackney and colleagues (2007) studied the effects of tango on movement for people with PD versus regular exercise. Both exercise and dance improved the movement for people with PD, but they found significant improvement in balance with tango in PD versus exercise (Hackney 2007). Studies show that the basal ganglia, the structures particularly affected by PD, are specifically involved in the control

[4] www.movementdisorders.org

of dance movements. Brown and colleagues have studied the brain of tango dancers through positron emission tomography (PET) and have found increased activity in BG and especially in putamen during dance (Brown et al. 2006). Dance is synchronization between music and movement, where music activates the reward center and movement activates the motor circuits. Reward center in the brain is located in mesolimbic dopamine pathway which connects nucleus accumbens (NAc) with ventral tegmental area (VTA) where dopamine is produced. Activating the reward center in people with PD who are deficient in dopamine is crucial for avoiding depression. Based on a review paper on eight previous studies on 43 PD patients, VTA degenerates in PD and 25% of people with PD have depression (Alberico 2015). Thus, activating VTA can be of a great help for the mood in people with PD.

On one hand, many researchers have studied the effects of music on mood. Hans Eckhart Schaefer (2017) has published an article which reviews up to date experimental, therapeutic and theoretical studies on the effects of music on emotions. Based on a review paper on Kreuz research, four musical parameters are important in evoking the emotions: tempo, consonance, timbre and loudness. Each parameter activates one part of the brain. For example, consonances are represented in the brain stem and modulate in amygdala which is responsible for feeling emotions (Schaefer 2017). Chanda and Levitin have also done extensive research on music and the brain. In an article in 2013, they showed that music improves health through neurological changes in four brain areas as: 1- reward, enjoyment, inspiration, 2- security, 3- stress and arousal, 4- social aspects (Chanda 2013). Oliver Sacks, a renowned neuroscientist, has done extensive research on healing effects of different types of music. He mentions that the type of the music is very important in being considered as therapeutic, for example in regard to people with PD, a patient of his, could only dance smoothly when the melody was played in legato. Staccato

or percussive music would cause her worse jerky movements. He has worked with a patient with epilepsy in whom any romantic music would provoke a seizure in him even if it was legato and soft (Sacks 2006). Different studies have researched the effects of familiarity on different regions of the brain. Castro and his colleagues, in 2020 have studied 16 musicians and showed that familiar favourite music activates the reward network in ventral striatum (Castro et al. 2020). Thus, type of the music, familiarity, tempo and beat are all important to be considered in using music as a tool for therapy.

On the other hand, other researchers have studied the effects of dance with Parkinson's on mood. Research by Lewis et al (2014) on 37 participants has evaluated the changes in the mood of the dancers during a ten-week dance class. The results showed improvements in mood and reduction in anger (Lewis et al. 2014). The component of dance in almost all classes for dance with PD is the same. The difference between classes around the world is the use of their music in terms of live or recorded. Although some classes in the world such as India bring in the elements of their traditional music in the classes as well.

Dance with Parkinson's Disease in Canada

In 2007, one of Sarah Robichaud's clients, asked her for help with his difficulty in movements due to PD. This was the beginning of Dance with PD in Canada. Sarah, a classically trained dancer, attended the teacher training program for Dance with Parkinson's Disease in New York with Mark Morris contemporary dance group and in 2008, started Dance with PD in Toronto. In 2013, Dr. Joseph DeSouza, and his research group at York University, started to research the effects of dance on the brain of people with PD in two locations in Toronto – the National Ballet School (NBS) and later Trinity St. Paul United Church. They recently focused their study on collecting neuroimaging through Electro-Encephalography (EEG) and first started

with functional magnetic resonance imaging (fMRI) brain scans from participants' brains while learning choreography. See a documentary on this aspect of the work produced by Karen Suzuki (2016) https://www.youtube.com/watch?v=q4yXyZjmWMI.

In addition to brain imaging, they also evaluated attention, working memory, and motor related PD symptoms through the use of MDS-UPDRS (Unified Parkinson's Disease Rating Score) and paper and pen questionnaires such as PD-NMS, PANAS-X etc. Part III of UPDRS was always videotaped so that a blinded certified MDS member could score the results to remove bias (DeSouza & Bearss 2018).

Structure of the Live Dance Classes with an Example from Canada

The format of the dance classes at Canada's National Ballet School (NBS), was an hour once a week with a certified dance instructor and a pianist. Each class had a number of volunteers who would watch for the dancers and assist them whenever needed. The elements of the dance class were a combination of jazz steps, ballet, Argentinian tango, dance theater, free style and choreographed movements.

Based on Mark Morris technique, the class maintained the following routine:

1- Welcome for opening: some game such as name game.

2- Warming up while seated with breathing exercises

3- Movements for upper body while seated

4- Movements for lower body while seated

5- Pair dance while seated: such as mirroring.

6- Standing poses close to the chair: such as ballet "Plié"

7- Moving around the room.

8- Free style.

9- Closing ceremony: always standing in a big circle, holding hands and bowing to each other saying" thank you."

10- A special thank you to the piano player from everybody.

Each part would be performed with a specific beat and the music would be matched with the narrative that the choreographer would improvise. For example, the instructor would choose the theme of swimming in a beautiful ocean under the sun, for a cold winter day. First, she would narrate the plot then she would show the movements. The piano player would either improvise or play a theme arranged to fit the story line. The instructor would ask him to increase or decrease the tempo based on the mood or capability of the dancers on each session. The pianist would continue playing as long as the instructor continued the narration.

Dancing at NBS or Trinity was more a theatrical dance which involved free imagination of the dancers at the same time. Participants in dance with PD Canada have built a community during all these years. They all look forward to Tuesdays and Wednesday to go to the class. Even if someone is not feeling in their optimal state, they drag themselves to the class because they know that they will feel better afterwards. At NBS the participants spend a good amount of time together after the class in the cafeteria of the NBS to chat and have cookies and coffee. The opportunity of socializing is another positive aspect which helps them to improve their quality of life. Heiberger et al. (2011), have studied the effects of dance on the quality of life of people with PD. They have used the Quality-of-Life Scale (QOLS) and Westheimer questionnaire and have found positive changes in the quality of life of the dancers (Heiberger 2011) as did our group in 2013 (Bearss et al. 2017).

A Report from a Dance for PD Class at Canada's National Ballet School (NBS)
November 5, 2019

Today at NBS I, along with, Ben and Mollia, conducted the UPDRS test on two participants. One was a dancer with PD and the other was a control group participant. The dance was fun and joyful for everybody as is usual. There were 21 dancers and ten volunteers with Bob at the piano and Angie instructing.

Seated: They started with pointing out to each other and saying hello and since it was cloudy outside, they imagined pushing the clouds away.

1) The dance began with a 3/4 beat waltz for warming up fingers, arms, shoulders, and toes.

a. Three Sets: Arm(s) outstretched with hand(s) open. Followed by curling fingers then hand(s) and arm(s) at 3 levels (at side, at chest, high above head). First set involved RH (right hand), second involved LH (left hand), third involved both hands.
b. 3 Sets: Drawing circles with toe of single foot (R, L, R) followed by 3 stomps (R, L, R). Order is switched for the remaining every set (Set 1 = R, L, R; Set 2 = L, R, L, Set 3 = R, L, R).

2) The theme for this dance was collecting the autumn leaves. It consisted of squish, open and crunching movements. The purpose of this part was exercising different breathing techniques.

3) The song, "Hit the Road Jack" an R&B (Rhythm and Blues) hit made famous by Ray Charles was played first by Bob on the piano and then a jazzy version with Angie's cellphone. Angie suggested a special choreography for this song to be practiced for an event in December. Everybody loved the song and would sing with it.

a. Stamp feet three times.
b. Slap thighs with hands three times.

c. Point index finger at three locations in a semicircular motion. Conducted twice, first time clockwise then counter-clockwise.

d. Move arms upwards to reach, then throw downwards. Completed three times.

e. Cross arms.

f. Stamp feet. Three stamps.

g. Pretend to ball something up (as if packing a sleeping bag) and throwing it.

h. Free expression. Dancers were encouraged to conduct positive (e.g., cheering) or negative expressions (e.g., pushing) that Jack is leaving.

4) Standing: Plié, was added with sending love from the hearts. Bob played "Una Furtiva Lagrima" for this move.

a. Feet beyond shoulder width apart, with toes pointing outwards at ~ 45 degrees Dancers were instructed to feel how their feet were planted on the floor, feeling the distribution of their weight.

c. Plié twice.

d. Raise one arm to the side while transferring weight to ipsilateral knee and bending it. Then return to original position by pushing back with the knee and lowering arm. Done once with each arm, then both simultaneously

e. Raise arm overhead (R then L) and feel stretch inside.

5) A Broadway music was played to move on sets of three.

I found this challenging for myself, as we are always used to symmetrical movements in sets of two or four. But interestingly most of the dancers were quite in synch with Angie and would not make a mistake! Perhaps they had practiced with this kind of movement but I have not noticed it since began attending the classes at NBS.

6) Same song played in a faster tempo (and I would still make mistakes with the set of three!)

7) They practiced the same choreography with the “Hit the road Jack” but this time standing.

8) An Argentinian tango was played for pendulum movements and tango steps to change direction behind the chairs.

9) At this time, they walked around the room dancing the same theme as collecting the leaves.

10) Last song was L-O-V-E by Nat King Cole with the same choreography as weeks before.

a. Focused on making L and V very sharp movements.
b. Focused on making O and E very smooth and fluid movements.

There was a lady who was yawning the whole time during the class, and I noticed how much she enjoyed this song and did not appear sleepy anymore. I am not sure what is about this song, but it seems to evoke excitement every time it’s played. Probably the meaning of the lyrics is a crucial factor in this response.

Now everybody stood in a circle holding hands. They bowed to each other one by one and finally they turned towards Bob and thanked him for playing the piano. At the end a lady made a very interesting announcement. She said that she is 81 years old and had been diagnosed with PD for 15 years. Now she is feeling so much better that her doctor has reduced the dose of Levadopa. She shouted, “there is hope for cure my friends.” Everybody was very emotional and many people gave her a hug. I asked her if dance has helped and she answered, “definitely.”
I did not understand what her real situation was but her speech was very impressive.
I wish her words echo in the universe and there comes a day that every one gets cured.

Testing the Dancers

The testing process consisted of one fMRI at the beginning of the period of the research and one at the end of each period of research. It also consisted of two parts each time: filling out

the forms of PANAS-X for evaluation of the mood and UPDRS test for evaluation of motor control, working memory and attention and EEG scanning, before dancing. Second part was the same tests immediately after dancing. The participants had to take home a more detailed questionnaire to fill out during the week and bring it back to the class the week after. This questionnaire is consisted of medication questionnaires and movement and non-movement problems in order to separate the EPS and PD symptoms. The EEG scans would be recorded on a computer to be analysed by a neuroscientist in a later date.

PANAS-X is a self-reported questionnaire as Positive/ Negative Affect Schedule which is used to measure both higher order and lower order emotional states which is representative of mood. Based on Watson and Clark, PANAS-X divides emotions into three categories consisting of basic negative emotional states such as fear and sadness, basic positive emotional states such as cheerfulness and daring, and other affective states such as inspired and interested (Watson 1999).

Based on an article preprint in 2019 from Dr. DeSouza's lab, the depressive symptoms of participants with PD with dancing was studied and the results showed positive improvements in mood related symptoms for PD (Ciantar et al. 2019). While PD is usually considered in terms of its motor symptoms, negative affective elements that significantly impact quality of life are also common. Depression is considered prodromal to the development of PD (Pellicano et al. 2007), and approximately 40% of people with PD are also diagnosed with depression (Cummings 1992). Abnormal activations of reward circuitry in the brain have been implicated in major depressive disorder (Ng, Alloy & Smith 2019) and impulse control disorder (ICD) in PD has been shown to be associated with reward hypersensitivity (Drew et al. 2020). The synchronisation of movements with music that happens in dance, and the process of acquiring

skilfulness in learning and performing movement, activates this circuit (Bar & DeSouza, 2016). The reward network described by Berridge & Kringelbach (2015) contains anatomical regions of prefrontal cortex (PFC), including portions of orbitofrontal, insula, and anterior cingulate cortices (ACC), as well as subcortical limbic structures such as the NAc, ventral pallidum (VP), and amygdala. These regions also monitor where the body is in space via the insula circuitry, another crucial skill that is trained and developed through participation in dance. The orbitofrontal cortex, a key node in the network, is an important nexus for sensory integration, emotional and hedonic processing. The reward center is located in mesolimbic dopamine pathway which connects the nucleus accumbens (NAc) with the ventral tegmental area (VTA) where dopamine is also produced (Alberico 2015). VTA neurons have been shown to degenerate in PD (Alberico 2015) and this degeneration is associated with nonmotor symptoms such as depression. Participating in dance has been shown to have a positive effect on depression (Akandere et al. 2011; Koch et al. 2007; Ciantar et al. 2019), suggesting that it may contribute to reducing the likelihood or incidence of depression in people with PD who are deficient in dopamine. To investigate this hypothesis, we conducted a pilot study to determine whether online dance programs would also have a positive role in elevating the mood of people with PD, comparable to affective changes recently shown in live classes (Fontanesi & DeSouza, 2021).

Many other studies all around the world have studied the effects of dancing on the motor parameters of the disease, such as the study by Delabary et al in 2018 which was conducted on 159 patients. Delabary also compared the effects of dance on motor movement with other kinds of exercise which showed a decrease in TUG or functional mobility with Timed Up and Go test (Delabary 2018). In addition, other studies such as qualitative research by Bognar et al. in 2017, shows the positive effects of dance on improving the social self for people with PD. Bognar's

team concluded that dancing for people with PD helps them to have benefits for emotional challenges (Bognar 2017).

Covid-19 Pandemic and Dance with PD

With the onset of COVID-19 Pandemic all live classes of dance with PD were canceled all over the world. Some closed earlier and some later. The last live class in Toronto Canada was held at NBS on February 25th. 2020. With the announcement of the pandemic situation, Dance with Parkinson's classes were officially closed on March 8th all over Canada. The people with PD, are considered as one of the most vulnerable stratums of society thus even with opening all other activities and gyms and schools, people with Parkinson's should take precautions to avoid contracting the virus. Sarah Robichaud announced the start of her on-line classes in March 2020 in an interview with the Global news. This class has been running since then and seniors from all over the country can participate every day and free of charge via Zoom. It's not only dedicated for people with Parkinson's, but all seniors can join. She mentioned that her goal for running online classes is to keep seniors active, connected and engaged during the lockdown and isolation (Global News 2020). Same decision was made in other countries such as the United States, Malta, England, Brazil, Germany, Italy, India France, Australia, and South Africa.

Dance for PD organization based on the Mark Morris foundation in New York, has 26 affiliates in different cities throughout the United States who are running online classes. Although each class may have its own content but almost all of them are free of charge (Brooklyn Parkinson Group, 2010-2020). (https://danceforparkinsons.org/resources/dance-at-home).

Structure of On-Line Dance Classes with an Example from Canada

Online dance classes were held differently in each country. From once a week to everyday and 20 minutes to one-hour length. In Canada the classes were running every day at 11:00 ET for 20 minutes via Zoom. It was all seated with the same routine as live classes while seated. The only difference was that the music was recorded and was normally with lyrics. Everyday approximately 60 people on average attended. Since the class was online and everybody with an internet in their home, could easily access Zoom, elderly without Parkinson's had also the chance to participate. Only a few cameras were on and most of them were off, and the cameras which were on didn't give the possibility for dancers to watch each other as they danced. They had to set it to speaker's view in Zoom to be able to see the instructor. Many people didn't know each other and although sometimes they talked at the end of the class, they didn't have the opportunity to connect to each other. At the end, much of the discussion centered around the internet quality, sound and questions regarding the moves, however sometimes for some participants, this was the only means of connecting with anyone during the day. The instructor on the other hand, didn't have a proper connection to the dancers to feel their mood and choose the songs based on that. Time was very limited, and she should have already chosen the order of the songs which would sometimes accommodate her own mood on that day. Since the instructor should talk while music is played, the quality of sound was not as good as it should be.

The situation was different in each country. In some countries such as France, online classes did not work. They started dancing online in Paris with only five people but, they preferred to switch back to live classes a soon as the economy opened. The music in Paris has always been recorded. Grenoble, France was dedicated to Dance with PD before the pandemic.

There used to be about 15-20 people dancing but a few months after the pandemic started the class in Grenoble closed. Although people with PD are considered one of the most vulnerable stratums for COVID-19, in some places such as Berlin, Germany, they preferred to dance in live classes. Their instructor mentioned that they used to have about 14 participants before COVID-19 but after pandemic, the number of the participants was reduced to four to eight people. She said that they were scared to come out of their houses. The music in both Berlin and Paris, has always been recorded. In other countries such as Australia, they started online classes, but the number of the participants declined so that in August only three people were dancing online. At the same time in the other part of the world, India, Pune, the number of the participants increased after the pandemic. The instructor mentioned that many people who had mobility issues, could now access the classes easily. He also mentioned that although India is very rich in dancing, older women are not so comfortable to dance in public and on-line classes have given them the opportunity to participate from their own private zone.

The situation in North America was different than Europe or Asia. For example, in Philadelphia, 12 to 18 people used to dance in the studio to recorded music. After the pandemic, there were still 12 people dancing on-line. The classes used to have live music at their studios and the National Ballet School, used to have a pianist in the studio. Although everyday there were about 30 people with PD joining on Zoom with Dance for PD Canada, on average only three to four people from NBS attended this class which was running with recorded music. NBS started having its online classes broadcast from their own studio with a piano player performing live music to keep the spirit of the classes as before. The last class which was broadcast from NBS had four participants with PD who used to dance there before the Pandemic. New Orleans used to have its classes with a live pianist and was keeping the same spirit with its on-line

classes. We could see the same pattern for Belleville, Canada. In the UK, London, they used to have live music while with on-line classes so they tried to keep the same spirit and pre-record the music with a live performer as the teacher danced. Everything was shared via on Zoom.

People living with PD, and the dance educators who work with them, have shown incredible resilience in their ability to adapt to new circumstances. The results of a study by Ghanai et al. (2021) demonstrate that virtual programs offer important affective support for people living with PD. This diagnosis can lead to social isolation due to impediments associated with the disease, and dance for PD programs provide an opportunity to build community among others with a shared experience. Worldwide mandatory isolation orders and virtualization of community programs and supports due to COVID-19 have led to heavy burdens, both financial and emotional, for people with PD and their caregivers. The level of participation from members of the PD community may be an incentive for the organizers to focus their research on strategies that motivate people with PD to join online classes. In addition to these significant affective improvements for people participating in dance classes online, a marked preference for live classes was expressed in Ghanai's study, associated with appreciation of social interactions that happen in live classes. Reasons for this preference, were primarily issues such as difficulty with using the technology and/or a preference for live music; however, missing social interactions contributed a significantly higher index to the preference for live over virtual formats (Ghanai 2021).

An Interview with a Pioneer Volunteer in Research of Dance with PD

When the idea of Dance with PD ignited in Toronto, Dr. DeSouza started recruiting people with PD from Canada's National Ballet School. One of the first people who agreed to

participate in the research program also agreed to be interviewed and having people such as this around after eleven years is an asset. Various tests have been done throughout the years and the collection of longitudinal data are priceless. However, gathering statistical data without assessing the emotions of the participants who undergo the difficult process of sickness and aging is merely rigid science which lacks the information on the hidden vulnerable sides of the humans. As Buddha says, “we are what we think.” It is unwise to eliminate the thoughts of a long-time participant from our research data? Since music and dance deal with the soul and the body together, it can be a good idea to have a conversation with the participants and ask about their feelings regarding the inability of science in dealing with an incurable disease and the hope that art brings for a better quality of life.

Interview with Bill B.

Date: June 04, 2022

Location: National Ballet School of Canada (NBS)

Time: 1:30 PM

Me: If you please introduce yourself?

BB: I am Bill Bartlette and I have Parkinson’s and approximately I think it’s 11 years. And I am 77 years old.

Me: So, you were talking about how you met Joe and the beginning of the dance?

BB: Well, my neurologist gave me the news of my Parkinson’s when I was 62 and it was like looking at opportunities and, just an introduction to ballet school and Joe and his research came along. So, I was eager to help, be a participant and also learn about Parkinson’s myself so with the combination of the dance, music and the movement and the research going on was a great asset, something I never thought I’d be doing like dancing at the ballet school.

Me: So, you start dancing here? Who introduced you to dance?

BB: The neurologist Dr. Masellis at Sunnybrook, he was my Parkinson's neurologist, he recommended me to exercise and keeping active.

Me: Can you tell me how did you feel with dancing, at the beginning how was it, then how did you feel continuing dancing and why did you continue dancing?

BB: Well for me first of all was the fear of coming to the ballet school at my age, but then it was also hearing the interest between the ballerina and Joe and the interest in research project, and I was eager to participate and as to help them with their studies but also learning about myself so when I keep, I was very excited after each class. It was motivation coming alive with the class. Before and after was like being energized each class was almost and also it was forming a community with other people like at the same time.

Me: tell me what dance itself means to you?

BB: Oh, I said before like it was coming alive, it was like having the coordination, seeing myself how I coordinate to music to be able to listen to music and interpret with an instructor, and being with other people, being connected with other people, with the same condition.

Me: When was the last time that you danced in a live class?

BB: The last live class I think was four years ago now. With Parkinson's my recalling memory isn't the best.

Me: So, it was before Covid?

BB: Yes. Just before Covid.

Me: So, you attended the last classes that were held in NBS?

BB: Yes.

Me: What significance or impact has dance for you in regard to Parkinson's disease. Do you feel any difference after dance at the same day or during the years?

How many years did you dance?

BB: Like I said I forget but Joe would remember but it's probably 8 or 9 years. It was like to be on the first classes they did here. But to be monitored as looking at the progression. It gave me an opportunity to forget about my condition with the dance and I was able to be with other people with same condition, moving and interaction with people even doing like the exercise where we would pair up with other partner and how one partner would be the leader and the other would be the follower, you had to be concentrated with the other person have you imitate, so you are on your toes with memory but you also had almost talking with dance to another person without speaking.

Me: Did you feel better after the dance, how long would you hold that good mood or better physical...?

BB: Well I started from the time I got up in the morning and I knew I was coming to the dance class, the excitement inside of myself of going out to an event, meeting people knowing that it's going to be like an enjoyment knowing that you are going to a recital or something but you are a part of it and then meeting other people was like joyful and then once the class started it was like being lightened up to do whatever you could do whatever state you could do the movements too but then it was also the after goal, the buzz of the class itself with what you had experienced, the joy of going to a wonderful movie or going to a concert you had that sort of a upbeat feeling almost like being energized with music and the pleasure, and there was also the aspect after the social having a cup of tea or coffee with a colleague and then sharing a bit what their, how they are handling Parkinson's, what kind of tricks or what kind of things that help them, they shared

that with others too. It was a complete forming of a community of people helping one another, like a support group but it's spontaneous support group.

Me: How do you feel about online dance classes?

BB: It's only 50% of the enjoyment, (it) isn't the same as the personal touch of laughter or whatever.

Me: But what about the physical activity? So, do you think it was beneficial with online classes? Did you do online dance?

BB: I did online classes very limited. I didn't have the initiative to do it alone. Part of it was like camaraderie of other people.

Me: Do you think that recorded music was better, or did you like the live music that Bob played over the years?

BB: Well, the live music was definitely spontaneous because it set the tempo of what we were doing, how well we were remembering the movements to the music and the pianist could adjust to that with the teacher. So, it was like if the teacher and the pianist were interacting with each other. But you didn't get it online. There was online where people still came together after the class online, talking about 10 minutes, over the enjoying this piece or enjoyed that piece, what was that piece, they sort of it brought them to the feeling of good pleasure they shared and experienced for that class.

Me: So, do you think recorded music adds to the online classes or not?

BB: No, it's not. It doesn't have the power that live music have. Well, a personal touch with a live instructor, even like coming to a class, having themes or colors of the socks or color coding each week like it was spontaneous, and people would say let's do this next week or party, let's wear yellow socks or wear whatever.

Me: Yah I liked that theme. What can you tell me about the effects of the Pandemic on your health in relation to dance program?

BB: (BB crying). It's hard for me to tell you that because, I can see myself declining without music. With my emotional feeling of isolation from other people, the solitude of it, but I think the reality of seeing that I am not able to move like I did before Covid, so it's made a big reality check for me to go from Nordic pole sticks to go to walker has been hard, the whole thing with the Parkinson's came, I had to accept it. I had Parkinson's and then I had to adjust, accept it and with that giving up driving was losing my ability to be independent and then filling it with Wheel Trans was sort of losing the ability to drive independently relying on Wheel Trans, but it still kept me active and mobile independent to sorts.

Me: How has your community become broken in Covid?

BB: Well thinking of that is fearful for me, (BB crying) because I remember how the class was before Covid and now with the Covid there are so many that have passed away from that (Crying) community of dance and it's a reality check again that what's down the line for me so it's like looking at people that were dancing with me and I used at look at myself as a survivor of Covid but the people that from dance community we've lost it hurts, it's hurting.

Me: Yes, I know, even in many other communities, Covid has affected many people.

BB: I am sorry (Crying).

Me: It's Ok do you want me to bring you some water?

BB: No, I just need a Kleenex.

Me: I'll get you one.

BB: Ok thank you.

Me: Sorry I didn't want to make you upset.

BB: No no it's a part of the Parkinson's, it's the ability to bring a barrier to emotions like part of expressing myself, so I am still unable to do it but hopefully it's difficult finding the words, finding the words to express myself. And then to have a façade to protection from remembering the way it was and the way it is today. So, it's like trying to get that spark back even like to build a new class with new students and being part of that restructuring, I feel almost like an honor to have such dedicated people like you and Joe and the researchers that was out there supporting us.

Me: Yes of course and we are very thankful to you because you are cooperating, and you are doing it for a good and bigger cause.

BB: It was a win win situation for me too because I was extending a hand to the researchers and also learning the technique of MRI and imaging before and after the classes like sharing the excitement the before and after the class aspect of movement and dance.

Me: So hopefully the classes will come back again.

BB: I am very hopeful for that and it's like light is at the end of the tunnel.

Me: Yes, it's always light at the end of the tunnel and you are strong. Here you are again at NBS.

BB: Well, it's hard for me, this morning it was more difficult than before to bounce back to stay positive. Like I feel I am always a positive person but when I got to meet you – before I was almost like not wanting to see the reality of what happened, like with seeing people having to go with deep brain stimulation and things and being present to, can I help somebody else? I said even the social after the class – how people helped each other with different techniques or a system that was available or whatever. People not only go to support groups to feel strong, but they also don't need it when they go to dance class or they got to support group class it changed their attitudes completely, they realized why I have been shining this, why were I participating. The singing with Parkinson's I never dreamed would be so beneficial either, the volume of my

voice isn't like it used to be and with that activity of singing I know I realized I am not able to sing anymore I can hum but I can't reach the vocal movements. So that's how it's to find people know that I am still smiling, looking at the best side, what I can do, not what I can't. Do what I am able to do.

Me: And we learn a lot from you. Thank you so much.

The interview with BB reminds one of Terpsichore, one of the nine Muses and the Goddess of the dance, who is known for playing her lyre and leading the dance. During this digital age and the pandemic, a new window opened and the concept of art serving a function beyond mere enjoyment became as magical as the mythology itself. Dance with Parkinson's (DwPD®) is one of those magical events that forever alters one's point of view and expands the perception of music and dance.

Receiving a diagnosis of a neurodegenerative disease such as Parkinson's and losing capacity for movement and agency during a global pandemic is a frightening and isolating experience. The shift to online delivery formats for essential arts-based programs and services such as Dance for PD has played an important role in buoying the spirits and hopes of people living with PD and their care partners. Having the opportunity to continue a familiar movement practice, or try it for the first time, in a supportive atmosphere within an online community clearly impacts mood and wellbeing.

The relationship between exercise type and depressive symptoms can be assessed through mood evaluation with PANAS-X, as performed in Ghanai (2021) brief study on online dancing post-COVID the PD community. Although the sample size is small, the t-test is significant and shows an improvement in affect after dancing online. In addition to noteworthy improvement in affect reported by people who dance online, the study also revealed another intriguing result. The

questionnaires administered revealed clear preference or in-person social interaction, even among participants who danced in virtual classes. BB's interview supported this finding and reinforced the importance of considering both physical and social aspects of the dance experience.

It is important that we consider and note other elements that may be involved in elevating mood in addition to music. The lack of social engagement and close contact with loved ones, friends, and community members during COVID-19 negatively impacts mental health for all people.

People living with a progressive diagnosis such as PD which affects mobility already have a very limited interaction with the outside world; attending classes online and feeling part of a virtual community can offer some relief for feelings of isolation.

This suggests that people with PD benefit from having access to online classes during the pandemic, and perhaps more generally in areas where transportation is an issue. Moving to music clearly has an impact on affect for people with PD but having access to a studio setting plays an important role, when available, in supporting social interactions.

In the end, the fact is that Terpsichore shall dance.

Conclusion

The following material presents a summary of the key factors in relation to studying the effects of music on human brain and some of the benefits and contributions of music in the field of health and wellness. It considers the limitations of this study and suggests possibilities for further research.

This tome sought to investigate the effects of movement to music (dance) as a healing factor, functioning on a level beyond mere entertainment. Individuals with Parkinson's disease were observed to assess the healing effects of music on those challenged by the condition. Volunteers with PD, many desperate for a solution or some level or relief, cooperated with the research process in hopes of a better quality of life through the blending of art and science. The findings indicate that moving to music has a positive impact on people with Parkinson's disease. This became even more tangible during the pandemic lockdowns (Ghanai 2021). Further studies reveal that regular dance participation promotes neuroplasticity in people with Parkinson's disease and activates different brain regions through visualizing the dance (Simon, Ghanai et al. 2022).

The study revealed the effects of dance activity on the brain of people with Parkinson's. In addition, clear, positive changes in mood combined with a more optimistic quality of life appeared in the volunteers participating in weekly dance classes where the world of art and science joined together. The joy that people with Parkinson's disease expressed after the classes was beyond words. David Leventhal's workshop at the National Ballet School in Toronto offered more information about the origins of his program and how the music and dance choreography were designed. For one year before the COVID-19 pandemic emerged, data was collected from volunteer dancers with Parkinson's disease at the National Ballet School in Toronto by a lab

team led by Dr. Joseph DeSouza. Tests related to assessing the motor and behaviour control and questionnaires regarding mood assessment (e.g., PANAS-X and UPDRS tests) were done prior to, and immediately following, the dance classes. During each class my observations were notated as a form of ethnography. The knowledge of the brain and the behaviour analysis that I acquired during this time was remarkable but the wisdom that I received was priceless. The value of dancing together to music during vulnerable life scenarios reinforces the human need for socialization. This reinforces the evolutionary aspect of music and dance. Parkinson's disease remains incurable, but treatments are available to alleviate symptoms and improve quality of life. Medical and surgical treatments can be effective but are linked to risk and negative side effects.

This research is a leading investigation into neural changes over longer-term dance training in people with PD. It also portrays the affective impact of online dance programs for people with PD during the pandemic. Previous research on dance with Parkinson's classes showed that depressive symptoms improved after attending class (as measured by the Geriatric Depression Scale/GDS). A dramatic increase in depressive symptoms occurred during the three-month period during which regular weekly dance classes were cancelled due to summer holidays (Ciantar et al. 2019). During the pandemic, Dance with Parkinson's was compelled to go online. Based on the research during COVID-19 lockdown, virtual classes satisfied an important need for people with Parkinson's disease, although not offering the same benefits as "live" classes, they proved to be better than no classes at all. The relationship between exercise type and depressive symptoms can be assessed through mood evaluation tests as performed in the online study of dancing in the Parkinson's community. Although the sample size was small, it is comparable to other dance studies, and the t-test is significant in showing important affective changes immediately after dancing online.

It is important to consider and note other elements that may be involved in elevating mood in addition to dance and music. The lack of social engagement and close contact with loved ones, friends, and community members negatively impacts mental health (Panchal 2021). People living with a progressive diagnosis that affects mobility often have a limited interaction with the outside world. Attending online classes and feeling part of a virtual community offers some relief for feelings of isolation.

Future studies on the potential for programs such as Dance for Parkinson's and other hybrid music and dance classes to impact multidimensional aspects of mood and function will also greatly benefit people living with Parkinson's. An interdisciplinary approach is advantageous bringing together patients, clinicians, researchers, and program providers. An important question for the future must detail the duration of positive effect, e.g., how long after class does the participant experience enhanced mood?

This research also studied the effects of moving to music on the Insula, a specific and important area of the brain which is activated during a wide range of situations such as experiencing pain, love, emotions, and enjoyment of music. The insula has also been suggested to act as a hub for connecting attentional control and memory related regions (Mayer 2007). The research studied a longitudinal investigation of neuroplastic and activation changes in the Insula while visualizing a choreographed dance. Data analysis of the research showed a decrease in activation of the right insula with a significant t-test in different time points, which reflects reduced demands on attentional processing, emotion, and/or memory replay (Simon, Ghanai et al., 2022).

Emphasis on discovering and promoting accessible ways of improving quality of life for people with Parkinson's, such as singing, or toning should be considered in future studies as

well. Toning, or singing vowel sounds, has been used for healing since ancient times. There are many qualitative research studies on the effects of singing, especially the benefits of group singing on mood, motor improvement, stuttering, etc. Further research is necessary with the collaboration of scientists and musicians and sharing ideas between researchers, program providers, and participants to find the possible benefits of singing for human beings and its effect on different brain regions.

In the end humans have evolved to use their bodies to both produce and move to music. These abilities can be studied from the perspective of health benefits. We live in an era where aided by technology, we have been able to increase our life expectancy exponentially in relation to our ancestors. However, longevity on its own is not a sufficient metric for a better life and it is necessary that we consider the quality of this newly found long lived life. The coalition of science and art may prove to be the beneficial factor in this case. In concern of vulnerable people this matter of life quality becomes even more important as we seek new approaches of complementary healing methods. Using the body to produce or move to music is very accessible and has been used for healing since ancient times. Researchers are now striving to better understand the specific nature of music and dance in more scientifically provable terms.

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