UNIVERSITY OF SCIENCE, ARTS AND TECHNOLOGY

BACHELOR'S DEGREE STUDY PROGRAM

ESSAY - 5

COMPREHENSIVE ESSAY READING - Part 2

MODULE – 49

[Instructions: Read the essay and when you encounter each set of questions, indicate your answer on the separate answer sheet.]

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THEME OF THESIS: The Power of Music On The Brain And Learning

INTRODUCTION

Music has an uncanny ability to penetrate the brain, motivate the listener and facilitate learning in ways like no other medium. Music's power on the human mind is still just beginning to be understood; much work and research has yet to be done. But what is known to date reveals a fascinating, almost magical influence it brings to bear on the human mind as to brain activity (both normal and abnormal), development and learning.

But what is music, really? Just various harmonic tones assembled, simple ink strokes and symbols on a page? What is it really? We know it enters the brain via the outer, middle and inner ear canals and then is processed into nerve impulses that enter the brain. But then what?

Beyond that, how is it that something so deceptively simple can blaze new pathways through our neuronal superhighway? How is it that certain music can penetrate through the foggy mists of a comatose patient or a stroke victim to illicit reactions and effect recoveries not otherwise attainable? How can it induce – or even, the reverse, halt – brain seizures as experienced by epileptic patients? Why is it that plants will grow toward the source of certain kinds of music? Is it true that music helps develop human cognitive and motor skills, memory, creativity, imagination, abstract thinking, and just plain learning? How is it that classical music such as that of Mozart can be demonstrated to boost significantly the IQ rankings of subjects in such things as abstract operations, like math, and spatial reasoning?

Music's activating effects on humans have been observable through millenniums of time. Who cannot recall music's use in summoning the masses, sounding a call to arms, motivating regiments by the thousands to go and offer their lives as the ultimate sacrifice in behalf of their nation – or worse, helping to drive its willing subjects to commit atrocities not otherwise fathomable against fellow humans? But one must also consider the opposite end of the spectrum – the incredible heights to which man can be lifted under music's influence, even in its creation. Consider the emotional heights reached in such compositions as a sublime Mozart adagio or sonata, a stately Strauss waltz, a dreamy impressionistic work by Debussy or Ravel, … the list could go on and on. Think of the thrill felt from the thunderous tones of a full concert orchestra, or a complete marching band, or a string quartet or wind ensemble. Think of the flamenco guitarist's pulsating rhythms moving flamenco dancers to lightning-fast, precision steps that pound out a passionate dance. Think of the childhood carousel, or merry-go-round, with its calliope-like organ reverberating, thrilling and delighting all the young (and not-so-young) riders.

So many, many different forms and styles are comprised by music, and yet … do we know WHY if affects us as it does? Or how? What are some of the latest findings, and what are their implications? What new uses are being found, and may yet be found, for music in educational and therapeutic settings? Before embarking on that discussion, I'd like to quote one source and use his words to address the question, "what IS music?" I could not put it more eloquently than these words:

> What is Music?
>
> Music is science
>
> It is exact, specific; and it demands exact acoustics. A Conductor's full score is a chart, a graph which indicates frequencies, intensities, volume changes, melody, and harmony all at once and with the most exact control of time.
>
> Music is mathematical
>
> It is rhythmically based on the subdivisions of time into fractions which must be done, not worked out on paper.
>
> Music is a foreign language
>
> Most of the terms are in Italian, German, or French; and the notation is certainly not English – but a highly developed kind of shorthand that uses symbols to

represent ideas. The semantics of music is the most complete and universal language.

Music is history

Music usually reflects the environment and times of its creations, often even the country and/or racial feeling.

Music is physical education

It requires fantastic coordination of finger, hands, arms, lip, cheek, and facial muscles, in addition to extraordinary control of the diaphragmatic, back, stomach, and chest muscles, which respond instantly to the sound the ear hears and the mind interprets.

Music is all of these things, but most of all

Music is art

It allows a human being to take all these dry, technically boring (but difficult) techniques and use them to create emotion. That is one thing science cannot duplicate: humanism, feeling, emotion, call it what you will. **(1)**

NEUROLOGICAL ASPECTS AND PROCESSING OF MUSIC

In approaching this subject, it is necessary to make some distinctions. We must distinguish between educating *in* music as opposed to *using* music *in* education … or put another way, teaching music as opposed to teaching *with* music. The research turned up often commented on the value of teaching children music from a young age, the many advantages of enriching a child's learning experience by including music education, among other things. Numerous studies have proven repeatedly that music instruction helps young ones develop perceptual, cognitive, and motor skills; increases their oral and memory skills; and builds their self-confidence, self-esteem and sense of accomplishment. These children consistently show higher IQ scores in such areas as spatial-temporal reasoning (the kind of intelligence needed and used heavily in higher math and science); enhanced reading, linguistic, and communication skills; and heightened aesthetic concepts like perceptual, imaginative, and visual abilities.

While there is no questioning the argument for musical education of children, the focus of this thesis is directed toward the use of music as a tool – in education, therapy, and other areas. This theme will consider how fundamentally inherent music is in human beings, the different ways in which it is used and can affect people, as well as how it is actually processed once it enters our ears. The last item will be examined first.

Music, like language, is organized sound. Both language and music rely on highly organized sound variations in pitch, stress and rhythm. They both are rich in harmonics, the overtones above the primary frequency that give a sound its resonance and purity. But unlike language, music's notes, chords and melodies carry no explicit meaning. So, why does music have such power and meaning to humans? The fact that music is processed at multiple levels, having physical, cognitive and emotional effects, may account for its power.

The musical brain operates from the final stages of pregnancy on, persisting throughout life. This fact alone gives strong evidence that neural mechanisms ideally suited to processing music exist, and suggests intentional purpose behind their design. Further supporting the idea of music's purposeful design for humans, research shows that among the thousands of cilia (tiny hairs) of the inner ear, lying flat in a row like piano keys, fully *two-thirds* of them respond *only* to the musical frequencies (3-20khz). Not only the ears but also structures in the human brain itself are primed to assimilate and make sense of music.

It is as if music were "invented" for the human brain, and the brain preprogrammed to process, organize and interpret music. The brain processes music through an extensive neural system that is widely distributed throughout both hemispheres of the brain. Beyond that, there are locally specialized regions of the brain that deal with different aspects of music. Whereas it was once thought that musical knowledge resided only in the right hemisphere and language was controlled in just the left, recent research shows otherwise. Both language and music contain various elements that involve multiple processing centers spanning both halves of the brain. The modules distributed throughout the brain that are used to process music also have nonmusical functions.

- **<u>Which statement is the most accurate?</u>**

570. It is as if music were "invented" for the human brain, and the brain preprogrammed to process, organize and interpret music. Music's activating effects on humans have been observable through millenniums of time. Who cannot recall music's use in summoning the masses, sounding a call to arms, motivating regiments by the thousands to go and offer their lives as the ultimate sacrifice in behalf of their nation – or worse, helping to drive its willing subjects to commit atrocities not otherwise fathomable against fellow humans? But one must also consider the opposite end of the spectrum – the incredible heights to which man can be lifted under music's influence, even in its creation.
571. Music, unlike language, is organized sound. Unlike a language music relies on highly organized sound variations in pitch, stress and rhythm. However, they both are rich in harmonics, the overtones above the primary frequency that give a sound its resonance and purity. But unlike language, music's notes, chords and melodies carry no explicit meaning. So, why does music have such power and meaning to humans? The fact that music is processed at multiple levels, having physical, cognitive and emotional effects, may account for its power.
572. Music is science. It is exact, specific; and it demands exact acoustics. A Conductor's full score is a chart, a graph which indicates frequencies, intensities, volume changes, melody, and harmony all at once and with the most exact control of time. Music is mathematical. It is rhythmically based on the subdivisions of time into fractions which must be done, not worked out on paper. Music is a foreign language. Most of the terms are in Italian, German, or French; and the notation is certainly English – and a highly developed kind of shorthand that uses symbols to represent ideas. The semantics of music is the most complete and universal language.
573. In approaching this subject, it is necessary to make some distinctions. We must distinguish between educating *in* music as opposed to *using* music *in* education … or put another way, teaching music as opposed to teaching *with* music. The research turned up often commented on the value of teaching

> children music from a young age, and the many advantages of enriching a child's learning experience by including music education, among other things. The musical brain operates from the initial stages of pregnancy on, persisting throughout life. This fact alone gives strong evidence that neural mechanisms ideally suited to processing music exist, and suggests intentional purpose behind their design.

Musical Organization Of The Brain

Ongoing musical training begun at an early age has definite effects on the brain's organization and development.

> Passive exposure to music, even at a very early age, can engage a type of information storage generally termed 'implicit memory.'… By mere exposure,… the infant brain tries to make sense out of the stream of sounds it encounters.… These implicit memory structures form a necessary basis for more active engagement with music, which can start with toddlers in preschool. **(2)**

One study of musical training with young children found that, following just 10 weeks of music training, children aged 4 to 6 exhibited EEG patterns similar to those of adult musicians. For the musical ear, comparing and analyzing such things as pitch variation, melody, and timbre recognition activate different parts of the brain including the "working memory" circuits. Music processing involves functionally independent modules, different neural mechanisms that specifically process melody, harmony, rhythm (including error detection), and music reading.

Some of the brain structures playing a part in perceiving, evaluating, and categorizing musical sounds are explained here below:

- Neurons – seem to be specifically sensitive to pure tone pitch, complex harmonic relationships, rhythm, and melodic contour
- Amygdala – controls emotional responses to music and sounds, evaluating it for its emotional meaning. It gets its data quickly, directly from the thalamus; this instant relay accounts for the type of immediate, near-unconscious reactions to certain music or sounds
- Auditory cortex – also receives and evaluates sound input, but gets it more slowly than the amygdala and then takes time to make a more cognitive assessment, allowing for a conscious, more reasoned response to it. Although cortical pathways take longer, they still lead to an emotional response, only one that is more likely within our control. Interestingly, in the musically trained, "the arrangement of the auditory cortex is much like a piano keyboard, with equal distance between octaves."**(3)**
- Hypothalamus – closely connected to the thalamus, this structure instigates emotional behavior, ensuring quick responses to incoming stimuli, especially reactions related to survival
- ANS (Autonomic Nervous System) – divided into two parts, the sympathetic and parasympathetic, this is a major neurological component of emotion; evidence suggests that different types of music stimulate various aspects within each division
- Superior temporal gyrus – this region of the right temporal lobe is shown to be highly active during casual listening to simple melodies, on PET scans

- Corpus callosum – this central bundle of nerve fibers connecting the two brain hemispheres is shown by magnetic resonance imaging to be significantly larger in musicians who trained from early ages; since the nerves controlling motor functions on both sides of the body pass through the front half of this structure, its size would logically be affected by acquisition of the keen coordination between hands (and sometimes feet) required to play an instrument
- Planum temporale – this part of the cortex in the temporal lobe is typically larger on the left side of the brain; however, in musicians possessing perfect pitch it is significantly more pronounced in size compared with the right side. It is believed that this area is devoted to analytically categorizing sound, whether used in music or in speech
- Motor cortex – the part that controls the fingers increases in size from doing piano exercise … even when the exercise is done mentally, only imagined! And in the right motor cortex of string players, there is a larger area of it being used (to control the left-hand fingers) and evidence of greater neuron activity; these effects are even more pronounced in those players who started at an earlier age

Furthermore, data from brain scans shows an enlarged primary auditory cortex in the left hemispheres of musically trained subjects compared to those of untrained subjects. For people who started training before age seven, or in those having absolute ("perfect") pitch, this difference in size is even greater. And the portion of the cortex that responds to piano tones is 25% larger in experienced musicians, again, even larger on those who studied at earlier ages.

MUSIC’S BASIS IN HUMANS

Music is a language unto itself; yet, it is dissociated from language, per se, or any other type of cognitive process. It is a specialized mode of knowing, a unique means of processing and comprehending a particular kind of nonverbal information. Through it we are able to express, share, discover, and understand aspects of our human condition and experience that could not be had through any other means. This uniquely human and nonessential capability allows for powerful experiences as we gain musical insights that are unattainable through any other experience.

The human brain, even of a very young child, has only to be exposed to music, and it will spontaneously repeat it, having learned it just that easily (e.g., a child listening to the Barney song and then, without prompting, singing it back again). Not so with exposure to language; you can’t cause someone to learn language merely by exposing them to the printed word. Music is a unique learning activity. And yet, it bears similarities to the learning of speech. Both involve extremely organized sets of sound in rhythm, pitch and stress. Both of them are full of harmonics. Nevertheless, musical “notes, chords, and melodies lack explicit meanings. So, why does music exist? … Why does it have such power to stir our emotions?”**(4)** Really, music is nothing more than sound organized. And yet, it is universal to all cultures worldwide.

Musicality is a specific trait of mankind, as is language; it sets us apart from and elevates us above other species. It is *not* necessary for our survival, does not serve any overtly vital purpose, other than our entertainment or enjoyment. The musical brain is, as all evidence shows, the biological birthright of all humans everywhere in all times. But it is uniquely our own.

Although we tend to ascribe human meanings to animals' behavior, "the vast majority, if not all, of animal sound-making has to do with such things as territoriality, signaling, courtship, and mating."(5) Although we often refer to the "songs" of birds or other creatures, it is highly unlikely that these animals "sing" for their own aesthetic pleasure, as if music were an enjoyable pastime for them. So, words like "birdsong" and the like are really misnomers. And there are other differences when it comes to animals and music.

Recent investigation reveals that animals rely on absolute frequency analysis, contrasted with humans, who perceive *relative* pitch. So, while it's true that some animals can be trained to distinguish between two different songs, they can only identify these in the key in which they learned them. If either song is transposed into any other key – thereby changing all the pitches – the animal can no longer identify it. By contrast, humans can recognize an old, familiar tune immediately, regardless of what key it is begun in. That's because we hear and learn all the different relationships between notes, no matter how large or subtle. We can hear the same song transposed into any key and still recognize it because we didn't memorize the tune based on absolute pitch; it is, rather, the "contour" of a song that our brains memorize and recognize. There are other differences in animals and music – cognitive limitations.

In humans alone, musical forms as simple as basic verse-chorus patterns, or as complex as extended symphonic movements, can be processed, understood and analyzed. This is because they are able to retain – internalize, analyze, interpret and memorize – musical information for vast periods of time. But in probably the most musical animal of all, the dolphin, their sound recognition is greatly limited. In the simple string of tones A-B-A, they can recognize the repetition of the second A *only* if each section is no longer than two seconds – quite a difference from humans!

It is true that we can't understand all of their vocalizations and hence, it could be argued, it is not fair to give them a *human* musical task such as the one noted above. But while it's true that animals have sound-producing and sound-processing capabilities, they are limited by time in their scope. That is, they process sound only as it occurs across time—in the here and now—and what they hear, they attach a meaning to and then react to. So when a cat responds to the sound of a dog or another cat, it simply processes the sound and reacts to it. Contrary to the human-like characteristics we so often attribute to them, animals are not conversing or interacting with each other in emotional interplay or interpersonal relationships the way humans do.

Several expert researchers in recent times have reached some exciting and dramatic conclusions, and in turn, they've shared their results with music educators. One clear message that has emerged from this is that scientists are now taking music seriously. Many more are devoting major parts of their careers to understanding musical behavior. So today, as never before, neuroscience (or neural science) and "neuromusical" study have emerged as serious, cutting-edge areas of research, not an exercise in frivolity as most would have once thought. Out of the many studies a number of important concepts have emerged, some holding exciting implications for the future of education.

The human musical brain begins functioning before birth, during the last three months in the womb. As soon as they are born, babies can be observed responding to music. This strongly supports the existence of neural mechanisms that seem perfectly (and purposely) designed to process musical information. But a further implication of neuroscientific research is the importance of lifelong learning in music.

Evidence for this comes from studying the other end of the life cycle. A group of retired nuns have volunteered to have their brains studied as they gradually reach old age. This ongoing study has yielded some preliminary findings, namely, that the more education one has had during childhood, the less likely it is for him to be afflicted with any form of cognitive dementia, such as Alzheimer's disease. To continue the pattern of continual learning from their childhood, the researchers have encouraged the women to learn new skills, such as learning to play an instrument (or an additional instrument, if they already play one or more). This underexplored area of research could prove to be one containing the greatest potential for new growth: expanding musical learning beyond just the K-12 boundaries, helping many more age groups benefit from this brain-enriching experience.

Another finding coming out of neuromusical research is that musical training beginning early in life and continuing onward affects the way the musical part of the brain organizes itself. Hodges cites Faita and Besson who "demonstrated that musically trained subjects had stronger and faster brain responses to musical tasks than untrained subjects." **(6)** He also refers to brain imaging data that show several other differences in the brains of the musically trained, such as the size and arrangement of the auditory cortex in their left hemispheres; size differences in the motor cortex of keyboard and string players; and the even greater differences in those who started musical training before age seven and those possessing absolute pitch (discussed previously).

Music is not just in the right side of the brain but is represented all across the brain. Musical processing is spread throughout the brain – from front to back, top to bottom, and left to right. It is more accurate to think of musical processing as engaging widely scattered areas of the brain. And selectively changing the focus of attention radically alters the patterns of brain activation, as shown in a recent study.

- **Which statement is the most accurate?**

574. Music processing involves functionally independent modules, different neural mechanisms that specifically process melody, harmony, rhythm, and music reading. One study of musical training with young children found that, following just 10 weeks of music training from 4 to 6 hours a day, children exhibited EEG patterns similar to those of adult musicians. Music is not just in the right side of the brain but is represented all across the brain.
575. For the musical ear, comparing and analyzing such things as pitch variation, melody, and timbre recognition activate different parts of the brain including the "working memory" circuits. Recent investigation reveals that animals rely on absolute frequency analysis, contrasted with humans, who perceive relative pitch. Most animals can be trained to distinguish between different songs, but they can only identify these in the key in which they learned them. If either song is transposed into any other key – thereby changing all the pitches – the animal can still identify it. There are other differences in animals and music – cognitive limitations.
576. The human musical brain begins functioning before birth, during the last 120 days in the womb. As soon as they are born, babies can be observed responding to music. This under-explored area of research could prove to be one containing the greatest potential for new growth: expanding musical learning beyond just the K-12 boundaries, helping many more age groups benefit from this brain-enriching experience. This strongly supports the existence of neural mechanisms that seem perfectly designed to process musical information.
577. Interestingly, in the musically trained, "the arrangement of the auditory cortex is much like a piano keyboard, with equal distance between octaves."**(3)** Neurons – seem to be specifically sensitive to pure tone pitch, complex harmonic relationships, rhythm, and melodic contour. Amygdala – controls emotional responses to music and sounds, evaluating it for its emotional meaning. It gets its data quickly, directly from the thalamus; this instant relay accounts for the type of immediate, near-unconscious reactions to certain music or sounds. Auditory cortex – also receives and evaluates sound input but gets it more slowly than the amygdala and then takes time to make a more cognitive assessment, allowing for a conscious, more reasoned response to it.

MUSIC'S EFFECTS AND USES

The musical brain is modularized and musical experiences, as we've seen, are multimodal, involving auditory, visual, motor, cognitive, affective and motor systems, at the very least. Each component of music processing and responding is likely handled by a different neural mechanism. It is similar to language, only the connection between location and function is much less clearly distinguished with music. Scientists are now identifying the structures and systems in the brain that carry out specific musical tasks. Responses to hearing music are classified as cognitive, affective, or motor.

Cognitive Components

A number of studies have indicated that the processing of music involves brain modules that are functionally independent from one another. A 1998 study found that the neural mechanisms for melodic, harmonic, and error detection in rhythm were all operated independently. With music reading, it was found to activate an area on the right side of the brain that parallels a left-side area activated during language reading. A study in 1997 indicated that familiarity with music, timbre recognition, and rhythm perception all activate different brain regions. And in a study from 1988, it was demonstrated that the electrical activity of discriminating, advanced music listeners was different from that of inexperienced listeners. The brain apparently uses working memory for music, comparing incoming musical information to that already stored – this based on a study from 1991.

Affective Components

The emotional response to music, while perhaps one of the most important topics of research, is also among the most difficult to study. Much yet remains to be learned about this vital aspect of musical experience. It is now understood that different neural structures are activated in response to positive and negative emotions and that these structures, located primarily on the right side, function apart from other music perception tasks and are separate from neural correlates of various emotions. One area of research, that of music in medicine, has found an effective use for music in reducing anxiety and fear in surgical and pain patients. Music has been shown in experiments to affect the biochemistry of the blood, in turn affecting emotional responses. One result is that doctors are able to reduce drug dosages and hasten recovery time by employing music in certain medical procedures. The implications are fascinating – more than simply distracting the patient, the music is actually effecting physical changes in the patient's system. But, again, much less research has been done in this realm than in, say, learning and sensory perception, so no doubt much more will yet be revealed in this psychological aspect of neuroscience.

Motor Components

The music experience has two "modes" – the expressive and the receptive mode; the brain's links between music and movement are fundamental to both. With the expressive mode, the making of music, it is obviously a kinesthetic experience for the body. One neurologist referred to musicians as "small-muscle athletes" in recognition of that fact. **(7)** In fact, in a study in the early 1990's, this was clearly demonstrated when brain scans were performed on professional pianists as they performed Bach on the piano. The results showed undeniably "that motor control systems were highly activated during performance. At the same time, other regions of the brain were strongly deactivated – in effect, switched off – which is a hypothesized indicator of focused concentration." **(8)**

Research also indicates that during the receptive mode, listening to music, there are physical and physiological responses. The physiological, which were touched on in the last section under music medicine research, include changes in blood pressure and heart rate, among many others. Physical responses include the automatic toe tapping, head or body movements we so commonly experience. Interestingly, researchers have been "using this natural response in [a process called] 'Rhythmic Auditory Stimulation' to enable Parkinsonian and stroke patients to regain walking and motor skills." **(9)** As has been pointed to already, much evidence supports the idea that music is modularized in the brain. This is further proven by cases of patients suffering with "amusia" (loss of musical function caused by brain tissue destruction). In these people, the loss of very particular portions of the brain has destroyed corresponding musical abilities in them. This leads to our next section.

Medical Aspects, Case Histories and Therapeutic Applications of Music

Time and again, the brain's musical capacities are shown to be stubbornly persistent and extremely resilient in cases of trauma. In the face of so many brain disorders, diseases and injuries, musical abilities are nevertheless able to be experienced in some capacity – regardless of whether we look at retardation, emotional sickness, savantism, Alzheimer's, deafness or blindness. In patients with Williams Syndrome, having an average IQ of 65-70, extraordinary musical abilities are often observed. Whatever the severity of the disability or illness, as music therapists will attest, the musical brain somehow still emerges and brings meaningful experiences to the patient. Even if *certain* musical functions are lost due to brain tissue destruction, not *all* music is wiped out.

Take the case of Isabelle. Although it's in no way obvious, Isabelle is missing part of her brain. In order to correct swollen and burst blood vessels in her temporal lobes, it was necessary to remove substantial parts of her cerebral cortex. And yet, there is no slurred speech or vacant staring, no facial twitches or muscular tics. But, despite her utterly normal and beautiful appearance, the effects of her surgery emerge once the music begins. Familiar tunes like holiday carols, traditional children's songs, even tunes like "Happy Birthday" can't trigger one iota of recognition when played without the lyrics – all songs she knew only too well prior to her operation. No amount of melody, whatever the song, can jog even a hint of memory for her, despite her musical background and past learning. However, call out just a few words or phrases of a tune and Isabelle has no trouble recognizing and naming a tune – the lyrics trigger her memory. In hearing itself, Isabelle has no problem; she can recognize such things as people's voices and the sounds of the natural environment, like birds singing and babies crying. "This is the most serious case of amusia I have ever seen," says psychologist Isabelle Peretz of the University of Montreal. **(10)** Isabelle's is indeed an especially pronounced case. Peculiar as her condition may seem, though, it is nevertheless profound how any of us can and do recognize music.

It's perhaps unfortunate that until very recently, the only way to peer into the foundations of music in the brain was to see them in a damaged, disrupted or confused state. A virtual mirror image of Isabelle's condition was the case of Russian composer Vissarion Shebalin, who suffered two left hemisphere strokes in the 1950's. These left him unable to speak or to understand word meanings. Yet, incredibly, he continued to compose and teach music, even producing one of his most brilliant symphonies (in the opinion of fellow composer Shostakovich). So, his loss of words without the loss of music again supports the idea of separate neural circuits controlling language and music in the brain. But it is rare that brain disruptions result in such neat isolation in the damage they wreak.

Most famous among classical composers suffering brain damage was Maurice Ravel. In 1933, he started making spelling mistakes and within short order could no longer read or even write his signature. Worst of all, however, he could no longer compose. This was especially a tragedy since he had the music for a new opera in his head and now had no way to get it out on paper. He still could play scales and still enjoyed listening to musical performances. It is not known in which brain hemisphere or exactly where his damage occurred. But for four more years, he lived with the torment of hearing music in his head that he could not express.

A more recent case was that of a composer and music professor who had a stroke in the right brain hemisphere, with a different result. He could still write and orchestrate music, but he lost the emotions that fueled the creativity in his compositions. From then on, he lamented how dull and lifeless he felt his works were. Not only do brain disruptions affect musical capacity, but something of the reverse is also true – music itself can effect therapeutic changes in brain function where damage has occurred.

There is evidence that a certain type of music therapy has behavioral benefits, as discovered by researchers working at different institutions in France. They report that "Melodic Intonation Therapy (MIT) promotes recovery from aphasia, a severe language disorder subsequent to stroke. MIT involves speaking in a type of musical manner, characterized by strong melodic (two notes, high and low) and temporal (two durations, long and short) components."(11) Studying several patients who'd failed to recover for some time, the researchers applied MIT and measured the brain's responses using PET scans and relative cerebral blood flow while the patients were listening; they compared MIT to standard word repetition. Their observations proved that by stimulating the left hemisphere region of the brain known as Broca's Area, MIT actually induced the restoration of patients' speech functions. Particularly interesting was that critical areas of the brain were activated only by "MIT-loaded" words but not by regular words. The authors of this study concluded that this reactivation of Broca's Area by MIT unlocked the restoration of speech. These and other similar findings hold great promise for treating disorders like aphasia and, beyond that, understanding the role of music in normal and abnormal brain function.

- **Which statement is the most accurate?**

578. Responses to hearing music are classified as cognitive, affective, or motor. Scientists are now identifying the structures and systems in the brain that carry out specific musical tasks. A study in 1998 indicated that familiarity with music, timbre recognition, and rhythm perception all activate different brain regions. A 1997 study found that the neural mechanisms for melodic, harmonic, and error detection in rhythm all operated independently. With music reading, it was found to activate an area on the right side of the brain that parallels a left-side area activated during language reading.
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580. Whatever the severity of the disability or illness, as music therapists will attest, the musical brain somehow still emerges and brings meaningful experiences to the patient. Even if certain musical functions are lost due to

brain tissue destruction, not all music is wiped out. Time and again, the brain's musical capacities are shown to be stubbornly persistent and extremely resilient in cases of trauma. In the face of so many brain disorders, diseases and injuries, musical abilities are nevertheless able to be experienced in some capacity – regardless of whether we look at retardation, emotional sickness, Alzheimer's, deafness or blindness.

581. Music has been shown in experiments to affect the chemistry of the blood, in turn affecting emotional and sensory perception responses. One area of research, that of music in medicine, has found an effective use for music in reducing anxiety and fear in surgical and pain patients. One result is that doctors are able to combine drug dosages and hasten recovery time by employing music in certain medical procedures. The implications are fascinating – more than simply distracting the patient, the music is actually effecting physical and emotional changes in the patient's system. But, again, much less research has been done in this realm than in, say, learning and sensory perception, so no doubt much more will yet be revealed in this psychological aspect of neuroscience.

The Mozart Effect

MODULE – 50

When it comes to therapeutic uses for music not all responses are alike. People respond differently and many kinds of music can have positive effects. New age, jazz, classical, medieval chant, reggae, even heavy metal, can help some feel better. But above the rest, the music of Mozart seems to eclipse all others in its remarkable ability to heal and soothe. Its unique capacity for positive stimulation of the brain has been dubbed “the Mozart Effect.”

The celebrated French actor Gerard Depardieu is one of the most famous patients of the distinguished French physician Dr. Alfred Tomatis. Tomatis has spent decades studying and applying the transforming powers of Mozart’s music; his results are quite astounding.

In the mid-60’s, Depardieu came to him, a stammering, struggling actor with voice and memory problems. Depardieu had been referred to Dr. Tomatis by his drama teacher. Recognizing Depardieu’s difficulties as stemming from deep emotional difficulties, Tomatis prescribed a strong dose of classical music – the young actor was to come in and listen to Mozart for two hours each day, for the next several weeks. Depardieu did as directed, with phenomenal results.

He began to experience physical and physiological changes after just a few sessions, and his speaking problems soon cleared up. When he returned to acting school a few months later, he had acquired such poise and confidence that his acting career thereafter flourished – he went on to become a most accomplished actor. And this from a man who says, “Before Tomatis I could not complete any of my sentences. He helped give continuity to my thoughts, and he gave me the power to synthesize and understand what I was thinking.” **(12)**

After working with more than 100,000 patients all over the world during the last 50 years, “Dr. Mozart,” as many of Tomatis’ patients call him, has discovered that Mozart’s music always achieved the best long-term effects, hands down. Regardless of the person’s musical background, their ancestry, their tastes, or even previous exposure to Mozart, his music never failed to help them express themselves more clearly, calm down, and improve in their spatial perception. Tomatis has helped people with learning disorders, listening disabilities, vocal and auditory handicaps – a truly stunning array of successes.

More Mozart Magic

Doctors continue to add Mozart's music to their medical arsenal as more and more of them witness its uncanny healing properties. For example, take the case of little Krissy who when born prematurely weighed merely 1-1/2 pounds and had a life-threatening condition. The doctors didn't expect her to live and put her on total life support. Krissy's mother begged the staff to channel a constant stream of Mozart music into the neonatal unit, which they did, and that along with occasional pats on the head was the only positive stimulation the baby received. But her mother credits Mozart with saving Krissy's life.

At the age of one, Krissy still could not sit up, and she wasn't able to walk until age two. She was introverted, anxious, and had poor motor skills.

> Despite all this, at age three she tested far ahead of her years in abstract reasoning. One evening, her parents took Krissy to a chamber music concert. For days afterward, she played with an empty tube from a paper towel roll, which she placed under her chin like an instrument, and she 'bowed' with a chopstick. Her mother enrolled Krissy in Suzuki violin lessons, and the four-year-old could immediately reproduce from memory pieces seemingly several levels beyond her physical ability. With the support of her parents, teachers, and fellow students, Krissy stopped wringing her hands in fear and began to socialize. **(13)**

Many more stories like this have been emerging in recent years, reinforcing to researchers the many beneficial effects on creativity, learning and health that derive from music, especially the music of Mozart. As more researchers continue to discover these, they've passed on their findings, inspiring new and innovative applications of Mozart.

- In the state of Washington, the Department of Immigration and Naturalization has taken to playing baroque and Mozart music while conducting classes in English for immigrants from Cambodia, Laos, and other Asian countries; the result is that the learning has speeded up, officials report.
- In Canada, the city of Edmonton in Alberta began playing Mozart string quartets in the city squares as a calming influence on the flow of pedestrians. Officials report that among other benefits, the activity of drug dealers has dropped in the area.
- Animals – Monks in French monasteries like to play music for the animals they care for and found that when they use Mozart's music, the cows produce more milk.
- Plants – The Ohara Brewery in Japan had an interesting discovery: when they played Mozart music near the yeast they use to brew sake, the density of the yeast increased tenfold, producing for the best quality sake.

Exercise for the Mind

The power of the Mozart effect became more publicized following studies done in the mid-1990's at the University of California's Center for the Neurobiology of Learning and Memory, in Irvine. There, researchers studied the effects of Mozart's music on children and college students. Professor Frances Rauscher and her assistants found that by having 36 undergraduate psychology students listen to Mozart's "Sonata for Two Pianos in D Major"

(K.448) for 10 minutes prior to taking a standard IQ test, they all scored eight to nine points higher on the spatial portion of the Stanford-Binet IQ scale.

Theoretical physicist Gordon Shaw, one of the Irvine researchers, suggested that Mozart music may "warm up" the brain. His suspicion is "that complex music facilitates certain complex neuronal patterns involved in high brain activities like math and chess." **(14)**

A more in-depth study followed, this one further testing spatial intelligence and comparing a Mozart-music group to two others – one listening to mixed sounds and the other to silence – testing 79 students, over a five-day period. As their spatial reasoning was tested, all three groups improved their scores between day one and day two, but with marked differences: whereas the silence group increased 14 percent and the mixed-sound group gained 11 percent, the Mozart group's pattern recognition boasted a whopping 62 percent increase! Throughout the subsequent days of testing, the Mozart group consistently achieved superior scores over the rest.

"Proposing a mechanism for this effect, the scientists suggested listening to Mozart helps 'organize' the firing patterns of neurons in the cerebral cortex, especially strengthening creative right-brain processes associated with spatial-temporal reasoning."**(15)** They concluded that such listening constitutes "exercise" that preps the brain for higher functioning.

Following the publication of the Irvine studies, many public schools incorporated the playing of Mozart music into their school environments as background, with resulting improvements in student performance and attentiveness.

Why music, and why Mozart? Why does music heal, nurture, harmonize, and rejuvenate? Does music itself have actual physical effects upon organic objects in its immediate vicinity, with soothing, restorative, reordering effects that restore balance and order?

First … about Mozart. None of us has ever heard of anything like a Bach Effect, a Beatles Effect, or any other – only of Mozart's effect. It seems his music has unique properties that only recently are being understood based on the universal responses they induce. Mozart's music is neither mind-numbingly complex, nor overly simplistic or tortured, nor especially soothing. It is, however, easily accessible, witty, charming, yet simple, opening up a way for us to reach somewhere deep inside. Tomatis feels that Mozart's music liberates and heals like no other can, by far beyond all others. For many of its devotees it seems to impart balance, and this in itself is an enormously therapeutic attribute.

This balancing of energies is, in fact, something that all systems of healing strive to achieve – to make us whole, stabilized, in a state of equilibrium and harmony. In this, Mozart's music seems masterfully adept; neither too fast nor too slow, it seems perfect. It is to the mind what whole foods are to the body – a complete, balanced offering with the full range of "vitamins," only in a sonic form. What? *Frequencies* as nutrients?

That's right. We know that musical frequencies directly affect the rhythms of our autonomic nervous system. That, in turn, regulates a whole host of biological and physiological systems in our bodies, similar to the way various foods have an effect. People are no doubt "fed" by a great diversity of music, but not all have the same effect, just as not all foods do. Not all impart stability and balance to our emotions. With the simple clarity found in Mozart's music, people like Dr. Tomatis are convinced that it does indeed have an ordering, harmonizing effect on the mind and body. One thing Tomatis especially liked about Mozart's music was its arrangement of frequencies.

Some people don't hear all frequencies properly, thereby creating a "deficiency" of certain ones. In the case of Gerard Depardieu, his frequency imbalance was determined and corrected by Tomatis' filtering of the music he had him listen to. By taking out certain frequencies and amplifying others, he effectively "fed" Depardieu's mind the proper balance of frequencies, correcting the deficiency and thereby helping his mind heal itself. Tomatis preferred to use Mozart because his music filtered better, more easily than that of other composers. The specific frequencies he filtered for Depardieu, and others, acted like "sound nutrients," vibrational nutrition, as it were.

And so, whether he knew it or not, Mozart and his prodigious body of work – operas, symphonies, concertos, sonatas – music for pianos, woodwinds, organ, and other instruments – written during such a short life span, much of it even in his childhood – left us a deliciously balanced, nutritious musical feast of healing sounds for all to enjoy … better than any other kind of music.

- **<u>Which statement is the most accurate?</u>**

582. In the state of Washington, the Department of Immigration and Naturalization has taken to playing baroque and Mozart music while conducting classes in English for immigrants from Cambodia, Laos, and other Asian countries; the result is that the learning has speeded up, officials report. Many stories have been emerging in recent years, reinforcing to researchers the many beneficial effects on creativity, learning and health that derive from music, especially the music of Mozart. As more researchers continue to discover these, they've passed on their findings, inspiring new and innovative applications of Mozart.
583. Regardless of the person's musical background, their ancestry, their tastes, or even previous exposure to Mozart, his music never failed to help them express themselves more clearly, calm down, and improve in their spatial perception. After working with more than 100,000 patients all over the world during the last half a century, "Dr. Mozart," as many of Tomatis' patients call him, has discovered that Mozart's music always achieved the best short-term effects, hands down. Tomatis has helped people with learning disorders, listening disabilities, vocal and auditory handicaps – a truly stunning array of successes.
584. One thing Tomatis especially liked about Mozart's music was his prodigious body of work – operas, symphonies, concertos, sonatas – music for pianos, woodwinds, organ, and other instruments. People are no doubt "fed" by a

great diversity of music, but not all have the same effect, just as not all foods do. We know that musical frequencies directly affect the rhythms of our autonomic nervous system. That, in turn, regulates a whole host of biological and physiological systems in our bodies, similar to the way various foods have an effect. Not all impart stability and balance to our emotions. With the simple clarity found in Mozart's music, people like Dr. Tomatis are convinced that it does indeed have an ordering, harmonizing effect on the mind and body.

585. A more in-depth study was conducted, further testing spatial intelligence and comparing a Mozart-music group to two others – one listening to mixed sounds and the other to silence – testing 79 students, over a five-week period. As their spatial reasoning was tested, all three groups improved their scores between day one and day two, but with marked differences: whereas the silence group increased 14% and the mixed-sound group gained 11%, the Mozart group's pattern recognition boasted a whopping 62 percent increase! Throughout the subsequent days of testing, the Mozart group consistently achieved superior scores over the rest.

The Power of Music as Therapy

MODULE – 51

Does music itself actually have physical effects upon organic objects in its immediate vicinity, and can it have soothing, restorative, reordering effects that restore balance and order? Yes, it does, especially in the right frequencies. Just as sound frequencies can set up patterns or shapes in liquids, powders, or crystals, so they have effects on physical matter. The pitch, harmonics, and frequencies all affect the figures or patterns created, which are infinite in their variety. Such forms can range from beautiful simplicity to chaotic disarray. And if liquids, gases, and other materials react this way to sound frequencies, what of the delicate cells, tissues, organs, and other structures of the human body?

"Vibrating sounds form patterns and create energy fields of resonance and movement in the surrounding space. We absorb these energies, and they subtly alter our breath, pulse, blood pressure, muscle tension, skin temperature, and other internal rhythms."(16) So, in a sense, sound helps shape and sculpt us inside and out. Science and medicine have sat up and taken notice.

In the field of surgery, for instance, physicians and scientists now understand that the frequency vibrations carried by music can have either a positive effect on patients, or – if it's the wrong music for a patient – a negative one. They also now realize that patients, even under anesthesia, continue to hear sounds around them. This is because the auditory pathway has extra wiring, as it were, so that the auditory fibers are not affected by anesthetics; hence, patients continue to hear even when unconscious. This has strong implications for the use of music therapy as an operating-room protocol.

In order to shield patients from unwanted, possibly harmful sounds and noises in the operating room, some doctors or social workers ask the patient to choose music that will be played before, during, even after surgery, through headphones they wear. The idea is to invoke the healing properties of beneficial frequencies, the power of music that is meaningful to the individual. The result is a more rapid recovery, lower risk of side effects or complications, fewer days spent in the hospital, and an overall more positive response to medical situations and treatments in the future.

Other research shows that musical therapy can help reduce fear and anxiety in surgical and pain patients. Since hearing music actually affects the blood chemistry, causing affective changes, doctors are able to reduce drug dosages and speed up the recovery time. Much more than just psychologically distracting the patient, music actually evokes physical changes in their physiology. It should be noted that this area of feeling responses, mood, and emotion is still rather recent, much less developed in neuroscience and psychology than are areas such as learning or sensory perception. More is yet to come.

Music therapy, though it only emerged as a profession in the mid- to late-20th century, has been used to alleviate illness and distress for centuries and across many cultures, such as in ancient Egypt, in Bible times, and so on. It can take the form of listening to recorded or live music, or as musical interaction between a provider (therapist) and the recipient (patient).

It has been employed with a broad spectrum of client groups including psychiatric patients, the developmentally disabled, the blind, the deaf, the physically handicapped, chemically dependent, autistic children, the geriatric population, prison inmates, victims of sexual abuse, and people with HIV/AIDS.

The following explores some medical and educational uses to which music has been applied therapeutically.

Educational

There is evidence that words and instructions can be remembered more easily when accompanied by music. Among other things, musical therapy has been used to help people remember information presented in HIV/AIDS programs, resuscitation techniques, and children's abdominal breathing techniques to relieve their asthma.

Anxiety Reduction, Relaxation, Promoting Well-Being

The sedative qualities of certain kinds of music and its ability to promote relaxation have led to its use in many innovative ways. Among these are the following:

1. Reducing anxiety in waiting areas prior to surgery, and preoperative relaxation in burn patient units.

2. Calming patients after they've received details of their operation.
3. Helping bone marrow transplant patients maintain their motivation, psychological well-being, physical comfort, and exercise endurance.
4. Minimizing anxiety in patients who are recovering from heart attacks, receiving chemotherapy, suffering with tumors, or undergoing addiction treatment.
5. Relaxing muscles on clients during chiropractic, massage, or physical therapy.
6. Reducing anxiety, mainly in children, through dental procedures
7. Hastening recovery in hospital patients by instituting hospital arts projects.

PAIN REDUCTION

Linked closely with reducing anxiety is the reduction of pain. In terms of brain physiology, researchers have discovered fascinating links between music and the perception of pain:

> Research … suggests that the limbic system contains a large number of opoid receptors which are highly susceptible to the presence of chemicals like endorphins which blunt the feeling of pain. Music listening, in some circumstances, seems to encourage the release of endorphins which in turn elicit emotional responses. This is particularly important in relation to medical interventions with music.**(17)**

This area, too, has seen many practical uses for music therapy. Some interesting findings coming out of these applications have been that women appear to derive greater benefits than men do; children and adolescents benefit more than adults and infants; and the most benefit is seen in dental patients and those with chronic pain. Some techniques employed include passive music listening, active music listening, music-counseling techniques, music combined with developmental and/or educational objectives, and music together with stimulation, biofeedback, or group therapy.

In Germany, over a period of some 20 years, research was conducted that showed Music's beneficial effects – results hard to argue with. In terms of lessened stress/anxiety and pain, both for short- and long-term medical procedures, significant differences were demonstrated between the musical and nonmusical groups studied. In addition, those receiving musical therapy were able to receive drug dosages reduced by up to 50 percent, along with a shortened recovery time in some cases.

Other studies have shown music therapy's ability to help the pain of spinal patients in physiotherapy, those with rheumatoid arthritis, and children undergoing painful operations. Some techniques used involve the synchronization of a patient's heartbeat with a musical rhythm to relax and lessen pain (in cancer patients for example), as well as to assist them in sleeping. Vibro-acoustic therapy uses a specially adapted bed or chair with built-in speakers, through which a low-frequency pulse tone is played. This has proven highly successful for people having pulmonary problems, rheumatoid conditions, or profound physical disabilities.

A more recent line of investigation centers on biochemical responses to music, primarily those related to the immune system. In these techniques, a patient listens to music while visualizing images believed to promote recovery or healing. What seems to result are "changes in biochemicals such as endorphins, cortisol, ACTH, interleukin-1 and secretory immunoglobulin A. The effects may be stronger when the music is live, improvised and paired with an imagery technique."**(18)**

Music has also proven helpful in rehabilitative settings such as with post-brain damage patients, children having progressive neuromuscular disorders, helping free the movements of patients with Parkinson's disease, and others.

Assisting the Aging, the Dying, and the Mentally Ill

Music has proven very useful in helping mitigate the effects of Alzheimer's disease in the elderly. It has improved their social behavior, vocalization, reality orientation, and face recognition, while reducing restlessness and agitation. One example is in the use of big band music. After playing this during periods of recreation, workers saw results like greater patient alertness, happiness, and higher recall of clients' past life experiences. In another therapeutic use, music of a calming, quiet nature was played in dining areas for dementia patients and when bathing them, helping to improve a host of difficult behaviors. Other activities such as sitting without having to be restrained, social interchange, participation skills, holding things, and relaxing have been improved in older ones with mental illness or learning disorders.

A newer field is music thantology, in which music is used to help address the spiritual and physical needs of those facing death. A related therapeutic use of music is in aiding people who are working through grief.

In psychiatric patients, many good results have been achieved with music therapy in lessening symptoms, encouraging appropriate behavior, and alleviating depression by adding relaxation techniques.

HELPING THOSE WITH LEARNING DISORDERS AND HEARING IMPAIRMENT

With new developments in technology, most hearing impaired people can now access music. There are advancements that now enable the deaf to play electronic keyboards, while various techniques using color and vibration assist deaf people to “hear” music.

In children with learning difficulties, musical therapy has helped boost their mental focus and attention spans, along with gradually better vocalizing skills, visual concentration, imitation, and initiating of ideas. It’s had a positive effect on their personal relationships and social play, reading and counting skills, while diminishing their aggressive and maladaptive behaviors.

In children with profound or multiple learning disorders, music has also opened new doors. Whereas it was once impossible for such children to have any part at all in musical activity (short of listening), a new technological combination changes all that. A setup of a sound processor, a synthesizer, and a sound beam makes it possible for them to create their own music; control sound any way they wish; and explore, discover, and express sounds. The child’s voice can be enhanced using the sound processor. The synthesizer can be played by those having some physical mobility, using any number of different body parts as best suits the individual. For those with severe disabilities, the sound beam coupled to the synthesizer produces sound by converting their body movements into various tones. The beam senses their movements and transmits the signals to the synth, which converts them into corresponding sounds, making a direct link between the physical motions and the sounds that result. Ongoing technological breakthroughs will no doubt improve these kinds of opportunities.

For those with dyslexia there is developing research in the field to help them become more active participants in making music. The evidence so far holds out hope for music’s ability to help them. In kids with emotional or behavioral disorders, there is evidence to show the benefit of playing background music in their classes and during play therapy to reduce aggression, improve concentration, and so forth.

In autistic children, communication is a major struggle. Here, too, it seems that music therapy is able to help, substantially improving their communication skills – for example, by learning words to music. And in developmentally disabled adults, background music has led to enhanced work-oriented behavior with fewer nonproductive actions.

Promoting Early Development

We've already seen how receptive infants and even the unborn are to the sounds of music in their early months of life. For example, prenatal exposure to violin sounds produces babies with significant advances in motor activities, linguistic development, and certain aspects of coordination and cognitive behavior. "Babies can distinguish between different types of music. Interactions between mother and baby which involve musical activities … may help develop bonds of communication and facilitate speech development."**(19)**

Other research has shown musical stimulation to improve development such as by encouraging the baby to suck and helping him gain weight; in cases of premature or low birth-weight babies, those musically exposed increased their food intake and weight gain while shortening their hospital stays. Musical nourishment enriches young brains, stimulating the formation of connections (synapses) and the growth of branch extensions (dendrites) in neurons.

CONCLUSIONS AND RECOMMENDATIONS

Considering what research has uncovered to date, the implications are that there is no easy way to predict precisely the effects of music on any particular individual's behavior. The conscious responses people have are unique for each person. While these only account for a portion of their emotional responses, the conscious component is significantly subjective, arising from a person's previous experiences (i.e., related perhaps to persons, places, activities, events, emotions, etc.) and are influenced by a host of unique personal circumstances (e.g., culture, social group, upbringing). Given such highly individualized determining factors, it is very difficult to accurately predict the effects of music on any one person's behavior. Therefore, neuromusical science has focused on identifying overall trends in the link between music and human behavior.

Certainly, it appears we are still only scratching the surface of neuroscientific knowledge, probably less so with respect to applying our findings to practical applications. I believe many therapeutic, educational, and other uses for music as a tool remain to be discovered and developed, for the good of mankind at large.

And yet, with what we already have accomplished and discovered, we can feel truly gratified and pleased with the achievements gained so far in using music with neuroscience to better the lives of many groups and endeavors: 1) as a therapeutic tool in so many fields of medicine and rehabilitative treatment; and 2) as an educational tool, helping teachers to teach and students to learn better.

Many more uses exist and will be found, I believe and hope. Music is, in my opinion, a wonderful yet powerful gift bestowed upon us by a loving, generous Life-Giver who wants us to realize our greatest happiness and enjoyment of life.

SUMMARY

In summary, I believe I have only partly accomplished the goals I set forth in my opening under "Objectives … Goals." I believe I succeeded in illustrating many of the hopeful findings and conclusions regarding music's effects and potential for good, both in learning and in therapy. How we can best put these findings to use is still being discovered. I also showed music's inherent place in the human experience. My ideas about showing how we might more fully exploit music's potential were only touched on but not developed in this research to the extent I would have liked to. Our need to go on finding ways to use what we've already learned, I think, is clear. This is proven by the awesome potential in music, which I believe, is equally obvious. What I'm not so sure of is how to utilize it more fully and how we will discover that. I think experimentation and a willingness to try new innovative techniques is probably a large part of the answer – innovative, bold, imaginative thinking. These traits will be required if we are to go on discovering and inventing new, ever better and more effective uses of neuromusical knowledge as it becomes available. As we contemplate the implications of music's usefulness to the brain as an adjunct to learning, we need only to review what we already know:

- Benefits of Early Exposure – It's quite safe to say, as numerous studies bear out, that music in education produces long-lasting effects in which the earlier the exposure, the greater the long-term benefit. It enhances abstract reasoning skills like spatial and mathematical reasoning, reading, and development of intellect: aesthetic literacy, perceptual, imaginative & visual abilities. It boosts cognitive skills in problem-solving, critical thinking, and academic achievement (e.g., higher SAT scores); it increases interpersonal development in self-esteem/self-confidence and communication skills; and it improves retention and motivation, as the following example illustrates:

- In the University of Houston's accelerated learning program, foreign students were learning English as a second language and English speakers were being taught foreign languages while listening to highly emotional classical music to emphasize speech patterns. Their success rate, plus retention level, was so high, the program was confident that students would learn to speak another language in 96 hours or less.
- Brain Stimulating Effects – "Few other stimuli have effects on such a wide range of human functions."**(20)** Music affects all of these systems: physiological, motor/movement, behavioral, cognitive/intellectual, and that of mood/arousal/ emotion. One study, in fact, showed that Mozart's music alone was capable of significantly reducing epileptic seizures in patients who all had frequent seizures, some of whom were in a *comatose* state! Looking at other mental states, music is able to stimulate a whole range of emotional reactions and states of mind. It can be a wonderful adjunct to learning, helping the mind to focus and concentrate better, and prepping the brain to perform higher functions with greater ease. To this end, several nontraditional music programs have been implemented, across many countries, to enhance young children's learning.
- In a slightly less usual study using rats, a research team at the University of Wisconsin found "that laboratory rats exposed to a Mozart sonata before and after birth were able to complete mazes more rapidly and with fewer errors than were rats

> exposed to minimalist music, white noise, or silence." (21) The exposure, lasting from before birth until 60 days after, was followed by five days of testing in mazes. The Mozart-exposed rats were clearly better at the mazes by day 3, and by day 5 the differences were even more noticeable.

Music is important to humans because of the broad, multiple responses it produces: because of its obvious effects on brain development and function, its ability to influence us on levels beyond our conscious awareness, its' obvious capacity to bring us joy in personal uses, and because of its powerful therapeutic effects.

Music's use in education has a strong, solid basis in cognitive psychology and in both educational and neurophysiological research. The brain responds more to rich learning environments that involve as many of its' processing centers as possible. Lessons that stimulate the senses, the emotions, and memory go a long way toward aiding comprehension and assisting in future recall as real-world situations demand. Today's educators are responsible for using what they know of brain-based learning to teach students possessing all different learning styles.

Since learning styles vary widely, all must be identified and addressed. Then, breaking from the tradition that uniform practices are effective for all, educators must teach with multisensory processes, create events, and introduce materials and/or ideas into the class-room that will stimulate brain development in all such diverse students. With the never-ending curiosity kids possess, there are plenty of opportunities for teachers to use music in the classroom, and it doesn't take great expertise in music to teach effectively with it.

So, why music? Sure, it's a lot of fun; but is it truly important in education? Author Norman Weinberger answers:

Absolutely. Music offers great opportunities for communication and expression, for creativity and group cooperation – plus, it's good for the brain and can enhance learning and intellectual development. Instead of asking, 'Why music?' perhaps we might ask, 'Why not music?' and 'How can I use music to my students' advantage to further my goals as an educator?'**(22)**

Indeed … I concur.

- **Which statement is the most accurate**

586. In order to shield patients from unwanted, possibly harmful sounds and noises in the operating room, some doctors or social workers ask the patient to choose music that will be played before, during, even after surgery, through headphones they wear. The idea is to invoke the healing properties of beneficial frequencies, the power of music that is meaningful to the individual. Physicians and scientists now understand that the frequency vibrations carried by music can have either a positive effect on patients, or – if it's the wrong music for a patient – a negative one. They also now realize that patients, even under anesthesia, continue to hear sounds around them. This was possible because the auditory pathway of the patient was specially equipped with an extra wiring device. This has strong implications for the use of music therapy as an operating-room protocol.
587. In the University of Harvard's accelerated learning program, foreign students were learning English as a second language and English speakers were being taught foreign languages while listening to highly emotional classical music to emphasize listening patterns. Their success rate, plus retention level, was so high, the program was confident that students would learn to speak another language in ninety-seven hours or less. The sedative qualities of certain kinds of music and its ability to promote relaxation have led to its use in many innovative ways such as eliminating anxiety in waiting areas prior to surgery, and preoperative relaxation in burn patient units.
588. Looking at other mental states, music is able to stimulate a whole range of emotional reactions. It can be a wonderful adjunct to learning. To this end, many nontraditional music programs have been implemented, across several countries, to enhance young children's learning. Music affects all of these systems: physiological, motor/movement, behavioral, cognitive/ intellectual, and that of mood/arousal/emotion. One study, in fact, showed that Mozart's music alone was capable of significantly reducing epileptic seizures in patients who all had frequent seizures, some of whom were in a comatose state!
589. For those with dyslexia there is developing research in the field to help them become more active participants in music. In kids with emotional or behavioral disorders, there is evidence to show the benefit of playing music in their classes and during play therapy to eliminate aggression, improve concentration, and so forth. Other studies have shown music therapy's ability

to reduce the pain of spinal patients in physiotherapy, those with rheumatoid arthritis, and children undergoing painful operations. Some techniques used involve the synchronization of a patient's heartbeat with a musical rhythm to relax and lessen pain as well as putting them to sleep.

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