5-19-2007

# The Process of Listening to Music: How it Modulates Nervous System Activity and Affects Emotion

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# The Process of Listening to Music: How it Modulates Nervous System Activity and Affects Emotion

**By**

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FINAL PROJECT SUBMITTED IN PARTIAL FULFILLMENT
OF THE REQUIREMENTS FOR THE DEGREE OF
MASTER OF ARTS IN LIBERAL STUDIES

Skidmore College
April 2007

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## Abstract

Music as a force, affects us from within us and can arouse us emotionally and physically. Music has been an important element in our culture since the beginning of time. Its power has been documented back to primitive times and has continued through early civilization, biblical times and now, to the twenty-first century. Recently, an emphasis on the music of Mozart has prompted researchers to look more closely at the power of music and examine its effect on human learning. Also, ongoing research is done on exactly how we hear and how we react to this powerful force.

Energy becomes vibration, and vibration produces sound waves. These waves travel through the air and enter our ears. In the process of organizing these waves, tones and overtones into music, composers use a varied collection of musical tools which mold the raw materials of sound into the beauty of music. The elements of melody, harmony, rhythm, dynamics and tempo combine to comprise a musical tapestry for the ear.

The human ear is an intricate collection of delicate organelles that all work in concert in order for us to perceive and process sounds traveling through the air. Sounds become nerve impulses that travel via the cranial nerves and are processed in distinct sections of the brain. Several sections of the brain have to collaborate for music to be properly understood. Several of these areas are also associated with speech and memory.

As music stimulates sections of the brain, neurotransmitters are released in response. These chemicals flood our brain causing an emotional reaction; an effect. They cause us to respond emotionally to what we hear. We may experience happiness, sadness, nostalgia or excitement. These strong feelings affect our

immune systems, our psyche and our overall wellbeing. Music is a strong motivator and pervades all aspects of our lives. The impact influences all races, cultures and religions.

## CHAPTER ONE

Music has been a powerful force within our culture since humans began to walk the earth. Researchers have not uncovered a single human culture that is without some form of music, and all human beings respond to musical stimuli, rhythm, tone and harmony. (Wallin, 11) Social anthropologists state that only the behaviors that aid in survivability will continue as a civilization evolves and so it is no surprise that music affects us today in the same way it did our ancestors. (Dissanyake, xvii) Ellen Dissanyake, the author of *Homo Aestheticus*, would go so far as to consider music to be biologically necessary. Dowling and Harwood, who wrote *Music Cognition,* state that music has a "biological adaptive value" (Radocy, 21). If it did not, the behavior of creating it would have been weeded out via natural selection. In *The Descent of Man*, Charles Darwin wrote "I conclude that musical notes and rhythm were first acquired by the male or female progenitors of mankind for the sake of charming the opposite sex. Thus musical tones became firmly associated with some of the strongest passions an animal is capable of feeling, and are consequently used instinctively…" (Levitin, 245) Darwin's statement underscores the strong influence that music has over both humans and animals.

It is clear then, that music has a powerful function as part of human evolution and our development as a species. It also has had a large impact on how humans function as part of groups and societal communities, as has been documented for thousands of years. In China, music was an extremely important part of all ritual ceremonies. Chinese emperors made great efforts to insure that the music of the day was in keeping with the order of the universe. The universe represents order, constancy and a communal connection to nature. It was important that their music should be consistent with these concepts. They believed that if it was not, there would be revolution and chaos. (Dossey, 276) In the bible there are stories about David playing the harp to cure Saul from mental turmoil. (Crussi, 38) Homer wrote that he would often tell his warriors to sing in order to fight off the plague. Swiss regiments, while serving the French King were forbidden to play “Ranz Des Vaches” for fear that it would stir up homesickness and cause entire ranks to desert. (Gonzalez- Crussi, 38) Clearly, the impact of music on us, as human beings, is age-old.

More recently the music of Mozart has been credited with increasing IQ, helping students achieve higher scores on exams and healing the sick. In 2001, Don Campbell published *The Mozart Effect: Tapping the Power of Music to Heal the Body, Strengthen the Mind and Unlock the Creative Spirit.* In this book, Campbell claims that music (and in certain chapters he specifies the music of Mozart) increases learning ability. He also states that music aids patients suffering from strokes, dementia, head injuries and chronic pain, reduces seizure activity, helps to lower hypertension, treats symptoms of autism, ADHD, migraines, anxiety and dyslexia, and increases creativity and the ability to concentrate. (Campbell, 1) As a musician, I wanted to believe that such things were possible. I was excited to be able to provide music for my students which would enable them to be more successful in school.

The theory that music can affect our ability to learn has attracted much attention. There was a study published by a research group at the University of California. Dr. Frances Raucher and Dr. Gordon L. Shaw concluded that students have increased spatial reasoning ability after listening to Mozart. They, too, refer to “The

Mozart Effect" as the vehicle for this change. Seventy-nine students were given a task to perform after hearing Mozart's Sonata for Two Pianos, K448. The task they were given to do involved visualizing the cuts that would have to be made in a piece of paper to create a specific pattern. The students were broken into three groups. Before being asked to perform the task, one third of the students listened to Mozart, another third listened to varied selections of music and talking, and the final third were exposed to silence. The students were given the test on five consecutive days. The data showed an increase in spatial reasoning ability. The students who listened to Mozart improved "significantly" from the first day to the second and the second to the third. There was also improvement in the group that listened to silence but only from the second day to the third. The researchers credited Mozart's music for the improvement in the Mozart group, while the improvement in the silent group was attributed to "a learning curve"; in other words, the more you practice a skill the better you will get at it.

After the release of Campbell's book and the publishing of the California studies, the claim that drew national attention was that listening to Mozart could make kids smarter and guarantee scholastic success. Parents ran to the stores for CDs and the Governor of Georgia, Governor Zell, asked the state to allocate $105,000 toward the purchase of classical CDs for the newborns of his state. (Demorest, 34) Steven Demorest, the author of the article "Does Music Make you Smarter" refers to studies that specifically show the benefit of musical instruction on overall school performance. Studies show that young students who study the piano perform better on spatial reasoning tests and overall SAT scores are higher in students who were involved in music programs. (Demorest, 36) However, the theory that listening to Mozart for ten minutes would have a profound, long lasting effect on reasoning or IQ remains unsubstantiated. In fact, subsequent articles have been published to contradict the claims of Mozart Effect advocates. In his article "Prelude or Requiem for the 'Mozart Effect," Christopher Chabris argues that the results are unreliable because the study was restricted to a single task; folding paper. He also suggests that listening to music stimulates the right cerebral hemisphere which is the same area of the brain associated with spatial tasks. Since both activities have a "shared right-hemisphere locus" the Mozart Effect claim is less convincing than if the music influenced more diverse areas of the brain. Finally he suggests an "enjoyment arousal" effect. (Chabris, 826) In other words, the subjects enjoyed the music so they performed well on the task. Clearly there are some questions that can be raised as to the validity of Raucher's claims and the discussion of this issue has been widespread and rather heated. In his argument against the study, Demorest wrote that to insist that the works of a single composer have such power over intelligence is "irresponsible and a poor application of science." (Demorest, 34) Although researchers have disputed the validity of the claims that music enhances learning ability and specific cognitive skills, there is little doubt based on my own experience that music can have a significant emotional impact on the listener, thus influencing the physiological reaction of one's brain and body, and hence one's mind. As we listen to music, the information that we receive creates a chemical change that alters us emotionally. This is the phenomenon I wish to explore in this paper.

Before I discuss how music affects emotion, it is important to have a clear definition of the term emotion. What is emotion? P.T Young defines emotion as a disturbed affective process or state "which originates in the psychological situation and which is revealed by marked bodily changes in smooth muscles, glands and gross behaviors."(750) In Latin, the word emotion is "exmovere" which means to move away. (Jourdain, 311) I would interpret this to mean that events that cause emotional response move us away from homeostasis and toward another state of consciousness. It is important to distinguish between emotion and mood. H. P Weld maintains that "emotion is temporary and evanescent; mood is relatively permanent and stable" (Meyer, 7) Similarly, Radocy maintains that the definition of emotion is "a particular type of affect reflecting a relatively temporary disturbance from a normal state of composure." (353) Emotions can be positive or negative. In his article, *Enjoyment of negative emotions in music: An associative network explanation,* E Schubert writes that "emotion describes a transient human condition that involves several dimensions, the most important being valence (positive or negative) and arousal." (19) The concept of emotion is clearly complex and continues to be the topic of extensive studies and research.

There are several well-known theories regarding emotion. The James- Lange theory, for example, holds that emotions are the result of physiological changes. Most people think that we cry because we are sad; the James-Lange theory would suggest that we are sad because we cry. The Schacter-Singer theory asserts that stimuli cause physiological arousal and by examining one's environment, one can determine what to attribute the arousal to. For example, the statement "I am jittery because I had a lot of caffeine" implies a non-emotional attribution. "I am jittery because I am nervous about going to the dentist," on the other hand, can be attributed to emotion. Proponents of the Cannon-Bard theory insist that physiological and emotional experiences take place independent of one another. In other words, you don't have to have one to experience the other. They can, however, take place simultaneously. For the purposes of this paper, I define emotion as a temporary mental or physical state that has valence and arousal caused by the reaction of the brain to aural stimuli.

With a working definition of emotion in mind, I would like to turn to sound, how it is produced and how sounds behave prior to the point of perception. Next, I will look at the structures of the human ear and the physical events that lead up to the perception of sound. Once the sound is perceived, it is processed by the brain. After a discussion of several areas of the brain, I will return to the topic of emotion as it is created by neurotransmitters and other chemicals in the brain as the result of musical stimuli. I will refer to this as the sound-emotion phenomenon.

# CHAPTER TWO

Music can have a profound effect on the mind and body through its emotional impact on the listener. It is my goal to explore this phenomenon and examine the chain of events that take place from the initial impetus of vibration, through the mechanisms of the human ear and the subsequent neurological processes that relate to emotion.

Swami Chetanananda writes on the ancient science of sound, "All this takes place from sound, from the basic vibration and combinations of vibrations interacting with one another. One vibration becomes like a string that has a pitch of a certain frequency and sets up various resonances. Each resonance in turn becomes like another string that sets up further resonances. And from this symphony of creative energy everything manifests. All things are forms of the creative energy, the Shakti, which is never separate from the Shiva, the Absolute. Through meditation, we experience HIM directly. We penetrate the maya and the matrika, the sound of the union of Shiva and Shakti, the vibration in which all is One. This is liberation." (Campbell, Physician 298) In this passage, the Indian philosopher explains that sound and vibration are at the very core of meditation and prayer and therefore are key to our spiritual existence. For many of us, listening to Bach, Mozart or Handel allows us to spiritually connect with God through such vibrations and resonances. The Swami is taking the metaphorical symphony and breaking it down to its smallest form. In this chapter, I examine sound starting from the basic element of vibration and then discuss how the vibrations travel and create sound waves. Sounds create pitches, which can be measured in frequency and intensity. Most pitches are complex and contain fundamentals and overtones. Each sound as it leaves the source has physical qualities attributed to it. Each Beethoven sonata and every Mozart symphony begins with a single sound. An examination what events take place to create this single sound is useful. Before we can understand how music influences us on a cellular level we should examine sound in its most basic form.

Vibration is the one key element in every musical sensation. Whether we are hearing the striking of a drum or the sound of the human voice, air molecules are set in motion, hence vibration. Sounds that vibrate in a recurring motion we hear as tone; those with an irregular or sporadic vibration are perceived as noise. (Radocy, 94) Many of the musical sounds we hear are produced by the vibration of strings (violins, piano), streams of air through a cylinders (flute, trumpet), vibrations from striking the head of a drum or cymbal, or the vibration of the vocal folds of the human voice. Vibrations displace air molecules. The molecules vibrate in a cycle necessitating molecular displacement. The cycle is defined as "the complete journey of a vibrating object from an original point, through both extremes of displacement, back to the original point." (Radocy, 94)
The time it takes for this displacement is called a period and the total number of cycles that occur in a certain amount of time is the frequency. The vibrations must have a frequency range between 20 and 18,000 hertz (cycles per second) to be discernable to the unaided ear. Hertz is determined by the number of cycles that are completed per second, or the speed of the vibration. (Bhatnagar, 195) Musical tones also have intensity determined by strength of the molecular movement and it is measured in decibels. Intensity creates sound pressure and the range of sound pressure perceivable by the normal ear is quite large. When intensity changes, the ear perceives a change in volume or loudness. The sound of a whisper from a few feet away might register at twenty decibels whereas a rock concert might register at one hundred and forty. So musical tones

are actually displaced air molecules created as the result of vibration resonating at a discernable frequency and intensity. (Radocy, 94) These molecules displace other molecules and create continuing disturbances resulting in sound waves. Sound waves travel through the air and can be reflected, refracted or diffracted. Sounds can be reflected which means they change direction suddenly, like hitting a brick wall. Sounds that are refracted are bent or molded by the environment. Diffracted sounds can travel through doors and other openings. Thus, sound is not contained; it travels.

There are also variables which affect the discrimination of intensity. The ear is most likely to pick up the tones which lie in the middle of the hearing range, or the range that is appropriate for hearing the spoken word. They are not as sensitive to tones that are on the outer extremes of this range. It is widely believed that as men age they are less able to hear the tones in the higher register, whereas women have trouble hearing in the lower range. This change in hearing ability is referred to as presbycusis. (Radocy, 101) Therefore, two tones of exactly the same intensity or volume, but of different pitches, may sound to the listener as having different sound energies. (Critchley, 44)

In their book, *Music and the Brain*, Critchley and Henson make a clear distinction between intensity and loudness. They state that loudness "refers to a particular sensation as determined by the discriminatory responses of a normal human observer while the other (intensity) is a physical quality which can be measured with the aid of instruments and expressed in terms of energy and pressure." (Critchley, 44)

The same dichotomy existing between intensity and loudness is also true between frequency and pitch. They are not necessarily the same. Radocy explains in "The Psychology of Music" that pitch requires "a human observer" whereas frequency is a physical property that is measured in cycles per second. That said, changes in frequency result in a change of pitch. There has to be a sufficient change in frequency however, or a change in pitch will not be discernable. Scientists refer to this as a difference limen or "just noticeable difference". (Radocy, 101)

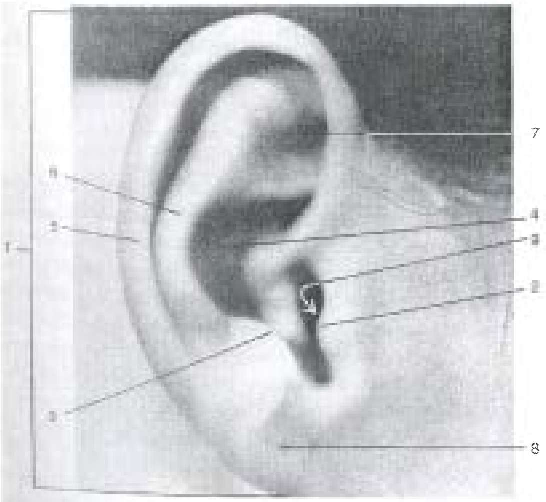
Most people would be surprised to realize the complexities of what they perceive as a single sound. Unless one studies the physics of music there are many aspects of sound that elude us. For example, not all tones are the same. "Pure tones" are those that contain only one frequency. These are not usually heard unless produced artificially. Therefore most pitches are considered complex tones, or tones that contain more than one frequency. Musical instruments create complex tones. The sound of a trumpet, for example, contains multiple frequencies, but the ear perceives it as one single pitch. The complex tone contains a "fundamental" and "harmonics," called overtones. The fundamental is the lowest frequency and the harmonics are the high frequencies. As Robert Jourdain points out in *Music, the Brain and Ecstasy,* each note is really a chord. When you hear an "A" you also are hearing the fundamental and its overtones. An A at 110 cycles per second has overtones at 220, 330, 440, 660, 770 and 880 cycles. The even numbered frequencies, being A's, reinforce the sound so we perceive it as A 440. Jourdain writes, "Most of us pass our entire lives without realizing that we're hearing many sounds in every musical tone. We fail to hear a tone's components largely out of inattention, just as we glance at a tree without noticing its individual branches." (35)
In my opinion, music is always with us, although we are often inattentive to it. More people listen to music today than in any other decade in history. (Levitin, 7) Modern technology has made it possible for us to never be without it. It pervades our lives at

home, in our cars and in our places of work. Our automobiles can now be hooked via satellite to a never-ending selection of genres and styles. Teens and young adults are physically connected via I-pods to their favorite “tunes”. Cell phones, which once were only used for conversation, can connect us wirelessly to music, commercials and web sites. Our society today seems to be uncomfortable with the concept of silence. Unless you are in the library or the woods, silence is rare. Music is all around us all the time following the pulse of our lives. People are unaware of how much of their waking time is filled with sound, and most are unaware of how the human ear receives sound and the intricate mechanics of the hearing process. I will examine this next.

# CHAPTER THREE

The brain receives a massive amount of information from all the senses in our body. Surprisingly, according to Norman Weinberger who wrote *Music and the Brain*, "the ear has the fewest sensory cells of any sensory organ – three thousand five hundred inner hair cells occupy the ear versus one hundred million photoreceptors in the eye…." yet our sense of sound clearly has a great impact on us. Because the ability to hear is crucial to the sound-emotion phenomenon, it is necessary to discuss the components of the ear and the auditory process. The ear has very complex and intricate apparatus. As sound vibrations travel through its many orifices and canals, a complex process takes place and the end result is our perception of sound in the brain. The outer ear serves to localize and collect the sound and serves as a resonator which aids in the perception of frequency. The middle ear changes vibrations into "mechanical energy" as the ear membrane (tympanic) begins to vibrate. (Bhatnagar, 197) The ear drum receives the momentum from sound molecules and responds with movement. This movement is transferred to small bones within the ossicular chain. Once the information has reached the inner ear and the cochlear duct (described on page 15), the vibrations are converted to neural impulses which can then be sent via the auditory nerve to the brain. It is truly amazing that such a complex process can take place within milliseconds.

When one looks at an ear, the first visible part is called the pinna or auricle. (on diagram) Most people do not realize that these flaps and folds of skin have an important function. The outer ear funnels or channels sound into the ear canal. Our pinnae work in the same way as the trumpets or horns that partially deaf people used to put up to their ears. The individual structures which make up the pinna are presented on the diagram below. The opening which extends into the ear canal is the external auditory canal. The cartilage in this section of the ear is coved with a thin, sensitive skin. There are also hairs and glands called ceruminous glands. These glands produce earwax which serves to help keep foreign objects out of the ear. (Tortora, 399) The outer ear and the auditory canal function together to maintain a consistent temperature for the eardrum, protect against moisture and injury. Research connects the outer ear to the ability to localize sound. (Crichtely, 33)


Lateral view of right ear
(a)

1. **Auricle.** Portion of external ear not contained in head, also called pinna or trumpet.
2. **Tragus.** Cartilaginous projection anterior to external opening to ear.
3. **Antitragus.** Cartilaginous projection opposite tragus.
4. **Concha.** Hollow of auricle.
5. **Helix.** Superior and posterior free margin of auricle.
6. **Antihelix.** Semicircular ridge posterior and superior to concha.
7. **Triangular fossa.** Depression in superior portion of antihelix.
8. **Lobule.** Inferior portion of auricle devoid of cartilage.
9. **External auditory canal.** Canal extending from external ear to eardrum.

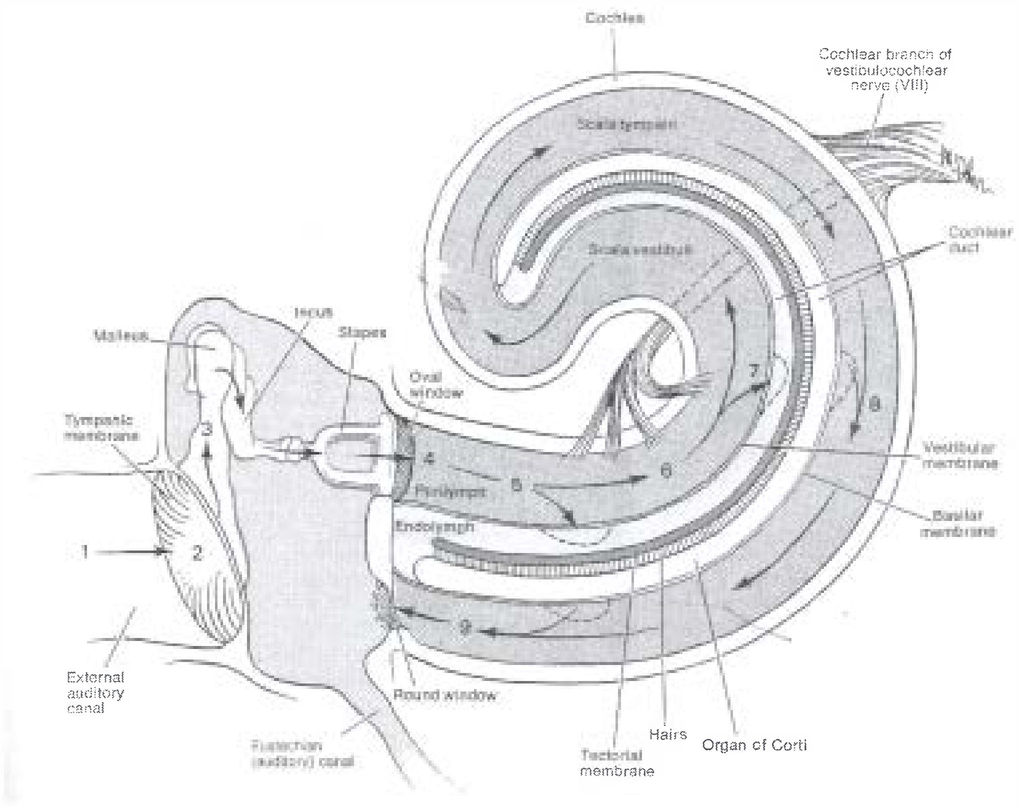
(Figure 17-9. Torora, 33)

The auditory canal narrows at the end to roughly 2.5 centimeters in the adult. A series of vibrations and sound waves enter through the auditory canal, or external auditory meatus, and the vibrations stimulate movement of the tympanic membrane or eardrum. The eardrum has a cone like shape and has a total area of 0.7 cm2 and it is 0.4 mm thick. Sound waves cause the eardrum to vibrate and the eardrum conveys the vibration to a series of small bones. These bones are the malleus, the incus and the stapes, also referred to as the hammer, the anvil and the stapes. These ossicles, as small as tiny pebbles, are held in place by ligaments and muscles. The malleus (the hammer) is the initial bone and is located roughly toward the middle of the eardrum, or tympanic membrane. The second one, the incus (the anvil) acts as a simple lever with the malleus and connects the malleus to the third small bone, the stapes. The very tip of the stapes connects to a small opening called the oval window where sound waves are sent to the middle ear. At the base of the middle ear is the eustachian tube. The eustachain tube allows the ear to regulate pressure between the middle and exterior ear. Air from the outside can enter or leave the middle ear so that the pressure is equalized. This is an important function because an extreme change in pressure can rupture the eardrum. (Tortora, 400) The middle ear has three distinct functions. The first is to convert acoustic energy into mechanical energy. The second is to equalize pressure, and lastly to control transmission of energy to the inner ear by regulating action in the ossicular chain. (Bhatnagar, 197) The mechanisms in the middle ear also determine the amplitude range the ear is able to perceive. (Sundberg, 41)

What I have demonstrated, then, is how vibration is funneled into the ear via the pinna and stimulates the eardrum and the three bones within the ear. At this point the vibration is converted into mechanical energy which transfers that energy from the middle ear into the inner ear.

At this point, the vibrations make it to the cochlea via the oval window and the round window. These two small openings separate the middle ear from the inner ear. The cochlea appears as a coil or snail like structure which circles around two and a third times and is roughly three and a half centimeters long. Within the cochlea are two chambers, one which starts from the oval window called the scala vestibuli and the other, beginning at the round window, is referred to as the scala tympani. These chambers connect to the cochlea through a connection called the helicotrema and are filled with fluid. This fluid is called perilymph and resembles cerebrospinal fluid. (Bhatnagar, 199) The walls separating the two chambers are called the vestibular membrane and the basilar membrane. The former is on the upper most side and is touches the scala vestibuli and the latter is on the bottom side touching the scala tympani. There is a third chamber between the vestibular and basilar membrane, the scala media, which is also filled with fluid. (Sundberg, 41)

Within the inner ear are labyrinth ducts, which serve to help with audition and equilibrium. These ducts are called the bony labyrinth and the membranous labyrinth. The membranous labyrinth is inside of the bony labyrinth. The bony labyrinth is filled with perilymph. A tissue called epithlelium lines the inside of the membranous labyrinth and contains a substance called endolymph. The following figure depicts the middle and inner ear structures.




(Figure 17-11 Torora, 403)

The basilar membrane of the ear plays a crucial role in auditory function. The membrane contains hairs that detect frequency. These hairs stretch across the membrane and respond when stimulated by a wide range of frequencies. Higher frequencies are stimulated at the end closest to the oval window and low frequencies at the other, closest to the helicotrema. It is similar to the layout of a piano keyboard. Within the scala media is the Organ of Corti, which contains sensory hair cells. These are primary receptor cells. The impact of a stimulus to the cilia of the hair cells in the basilar membrane causes the stimulation of more cells resulting in action potentials. (Bhatnagar, 200) In other words, the vibration from the music/frequency travels through the vicious fluid influencing the sensory receptors. The ion channels in the receptor membranes open exciting the cells of the auditory nerve. The organ of Corti is 1/250th of an inch small, yet its function is significant. It contains 14,000 receptor cells. These cells transmit the information to 32,000 nerve fibers. (Jourdain, 12) The information then travels to the brainstem cochlear ganglia and on to the auditory parts of the brain.

To summarize the sequence of events that take place in the ear, it begins with sound waves. These waves are directed by the pinna into the external ear canal and strike the tympanic membrane causing it to vibrate. This then starts a chain reaction and the vibration is transmitted to the malleus, then to the incus and stapes. The stapes then picks up the vibration, which pushes on the oval window. Waves are created in the perilymph. The perilymph of the scala vestibule then push toward the cochlea. Pressure is built up in the vestibular membrane and this affects the endolymph in the cochlear duct. The basilar membrane influences the scala tympani, which continues the momentum to the round window and toward the middle ear. The hair cells in the basilar membrane vibrate affecting the organ of corti. The hair cells of the organ of corti stimulate the neuron dendrites and the sound wave is changed into nerve impulses. The nerve impulses go through the vestibulocochlear nerve (number VIII) until they reach the auditory area of the temporal lobe in the cerebral cortex. (Tortora, 403) (See diagram)

At this juncture the sequence of events originating from a sound has lead us from the outside world and through all the intricate structures of the ear. The sound, which has been transformed into nerve impulses, leaves the ear structure and is sent along a neurological superhighway, the auditory pathway, to the brain.

The central auditory pathway is made up of several parts including the cochlear nuclei, the superior olivary nuclei, the lateral lemniscus, the inferior colliculus, the brachium of inferior colliculus, the medial geniculate body, and the primary auditory cortex in the transverse gyrus of Heschl. The cochlear nuclei receives information from the dorsal and ventral branches of the eighth cranial nerve. The cochlear nuclear structure sends "projections" to the ipsilateral (same side of the brain in relation to the ear) and contralateral (opposite side of the midline) ascending pathways. It is important to note that most auditory fibers cross the midline of the brain. (I will return to this fact later when discussing how music affects both the right and left hemispheres.) The superior olivary nuclei, within the pons (part of the brain stem) receive information from the cochlear nuclei and process information from both ears and judges differences in volume and distance or time. The lateral lemniscus is one of the most important ascending pathways. It receives information from both ears and passes it on to the inferior colliculus. Because of this bilateral function, a lesion in the auditory pathway will not result in total deafness, but only deafness in one ear. The inferior colliculus sends information to the medial geniculate body of the thalamus, the superior colliculus in the midbrain, the reticular formation in the brainstem and the cerebellum. The inferior colliculus controls our ability to sense the direction of sound and turn our eyes and heads toward it. The brachium of the inferior colliculus is an arm-like bundle of fibers that connect the inferior colliculus to the medial geniculate body. (Bhatnagar, 408) The medial geniculate body is part of the thalamus. This structure is responsible for passing information to the primary auditory cortex and auditory association cortex. The primary auditory cortex section of the brain is responsible for determining frequencies and the ability to hear pitches/words in the order that they are presented. It is also associated with the language cortex of the brain and specifically the area known as Wernicke's area.

Words and sounds are recognized and interpreted and we then comprehend language. (Bhatnagar, 201-203) If you follow the lines on the right side of this diagram, it depicts the connections of the auditory pathway.

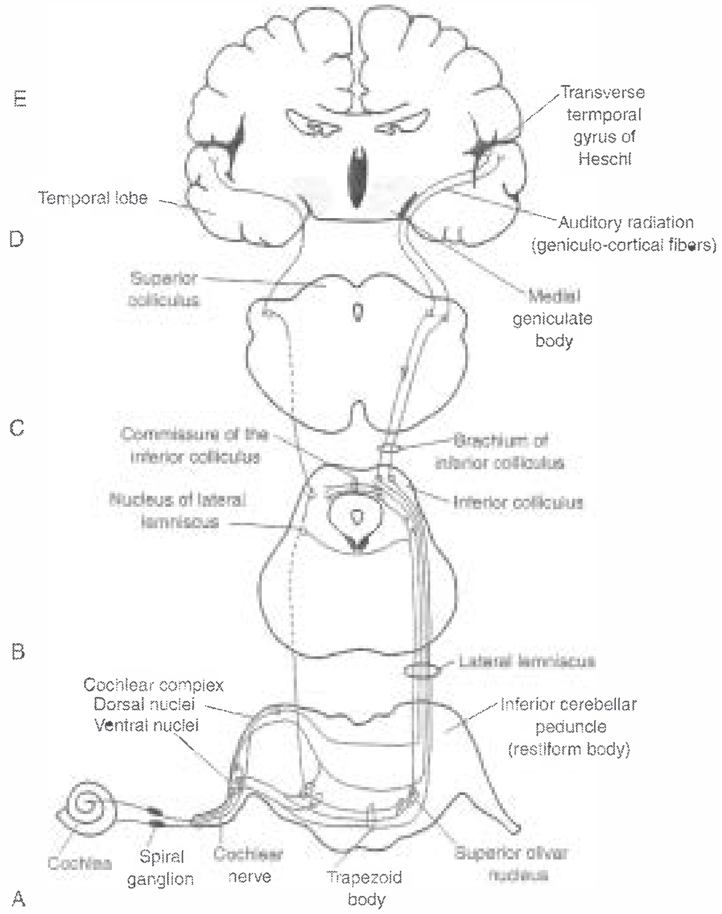



**Figure 9-7.** Auditory pathways. Central auditory pathway begins as secondary fibers arising from cochlear nuclear complex and forming crossed and uncrossed stria. These fibers synapse on the superior olivary nucleus and ascend through the brainstem to the auditory cortex. **A.** Medulla. **B.** Pons. **C.** Inferior colliculus level. **D.** Medial geniculate body of thalamus. **E.** Transverse gyrus of Heschl.

(Figure 9-7. Bhatnagar, 201)

It is interesting to note that not all hearing takes place through the process I have described. Bone conduction takes place when sounds are perceived via vibrations of the skull. We are able to hear our own voices in this manner. Vibrations are set off in the skull as a result of sounds within the mouth. (Sundburg, 42)

All the minute workings of the hearing process constitute a miraculous system of the human body. This ability is often taken for granted until something happens to affect our hearing. Beethoven was believed to have become deaf around the age of fifty due to a malfunction in cochlear hair cells causing a syndrome known as "loudness recruitment." (Jourdain, 19). The cause is yet unknown, but historians hypothesize it was caused by lead poisoning. Only rarely can a composer work without benefit of auditory acuity. Beethoven is a perfect example.

Young people today are doing considerable damage to their hearing with the use of I pods, which direct loud music inside the pinna and directly into the ear canal. Studies show that one third of the American population suffers a hearing loss due to extremely loud music. (Radocy, 127) When the ear is subjected to continuous loud noise, the auditory system initiates a protective mechanism. When the ear perceives a sound which is unsafe, a "temporary threshold shift" results. This mechanism serves to protect the ear. In essence, it is a temporary hearing loss. (Radocy, 127) This is accomplished by the movement of two muscles; the tensor tympani and the stapedius. These muscles can contract within forty milliseconds of receiving a sound. The tensor tympani pulls on the malleus and the stapedius muscle pulls on the stapes. By pulling in opposite directions, this action makes the middle ear very rigid thus decreasing the sound by between thirty or forty decibels. (Guyton, 637) Over a prolonged time, however, this shift can become permanent and a higher volume level will be needed for the listener to perceive the sound.

I have demonstrated how sound moves from outside the ear through the internal structures of the middle and inner ear. Now that the transition through the ear and the auditory pathway is complete, the aural stimulus has been converted from mechanical impulse to nerve impulse and is sent from the subcortical (areas below the cerebral cortex) to the cortical areas (areas involving the cerebral cortex) of the brain.

# CHAPTER FOUR

To truly understand the sound-emotion phenomenon, it is necessary to observe the neurophysiological processes that take place between the reception of aural stimuli and the end product of feeling. Working in concert, several structures of the brain provide the necessary continuum of events that lead to an emotional reaction. Once the neural code of sound is sent to the brain via the auditory nerve it is transmitted to parts of the brain that process sound. When the auditory signals reach the cortex, they are selectively processed by different areas of a highly interconnected network of brain areas in the primary auditory and association cortex.

How is it possible for us to know which areas are involved and which are not? Neurologists have found relatively non-invasive means of looking at the brain as it is functioning. Physicians and neurologist alike often use positron emission topography (PET scan) to determine when a particular area of the brain is stimulated. A small amount of a radioactive substance is injected into a patient's bloodstream. The scan can detect areas of the brain where the blood capillaries have dilated and an increase in the release of glucose is apparent. It conversely shows the areas of the brain where there is no change in activity. The location of brain activity will depend on what task the patient is being asked to perform. Another technology that looks inside the brain is functional magnetic resonance imaging (fMRI.) Using this machine, a large magnet surrounds the head and changes the direction of the magnetic field (Change affects the hydrogen atoms in the bloodstream). When levels of blood oxygen increase, a signal is sent from the particular part of the brain where an increase or decrease in activity is taking place. (Jourdain, 283) Electroencephalograms can also take measurements of brain waves during a particular task. Devices like these have allowed scientists to somewhat localize brain activity while listening to music.

Sound processing takes place in both the right and left hemispheres. There is a primary auditory cortex in both hemispheres of the brain and there are commissural fibers connecting the auditory areas of both hemispheres. (Bhatnagar, 203) The primary auditory area and the auditory association areas are part of the temporal lobe. The primary auditory cortex is located in the forward area of the transverse temporal gyri (Heschl's convolutions) inside the lateral fissure. (see diagram on page 22) (Montemurro, 44) This area is responsible for determining pitch and rhythm. Part of the auditory association area, also known as Wernicke's area, is located behind the primary auditory area on the bottom of the lateral fissure and includes areas of the superior temporal gyrus on the side of the temporal lobe. (Montemurro, 44) This area determines the difference between music, noise and speech. The different structures of the auditory association area are commonly referred to as Brodmann area 41 and 42.

Different areas of the brain interpret different aspects of sound. The primary cortex processes individual tones whereas the auditory association area, or secondary cortex, processes the correlation between many sounds. Sounds that occur simultaneously, like a chord for example, would be processed in the right side of the auditory cortex. Because much of the left auditory cortex is associated with speech, it is not surprising that it is also responsible for sequencing tones as well as words. In other words, it makes sense of what it hears in the order that it hears it. Speech and music share the characteristic of rhythmic pattern so it follows that both would be processed on the same side.

It is important to note that information coming in from the right ear may not necessarily be processed by the right side of the auditory cortex. As I mentioned earlier, several neurological pathways cross over the midline to the opposite side of the brain. However, because of the ipsilateral and contralateral projections, a lesion or damage in the left side of the brain would not cause a total loss of rhythmic ability. (Jourdain, 56, 57) This is because both hemispheres of the brain participate in the processing of rhythm. Limb, Kemeny, Ortigoza, Rouhani and Braun confirmed using MRI that "a shared network of neural structures" are involved, specifically bilateral superior temporal areas, the left inferior parietal area and the right frontal operculum. The authors also found that musicians have greater left lateralization for rhythmic processing than non-musicians. They concluded that musical training stimulates other areas of the brain, some of which are associated with language. (Limb, 389)

Studies have shown that the superior temporal and frontal cortices on the right side of the brain are predominately responsible for the interpretation of melody and harmony. Melodies are comprised of multiple musical aspects including pitch and duration. Sequencing of notes and melodic contour are involved as well. It is surprising to note that most musicians process melody on a different side of the brain than non-musicians: they process melody more in the left brain. Jourdain writes that "Professionals are lateralized differently from ordinary listeners because they acquire additional, quite different skills for melodic analysis. Rather than just hearing a melody as a unified contour, musician also break the melody into sequences of fragments bound together by abstract relations. Dominance for processing melody extends from a predominantly right sided function to the left as a result of musical training. (84) Because melody is processed bilaterally in musicians, a lesion in one area does not completely obstruct melodic ability.

As I mentioned, because music is processed in so many diverse areas of the brain, damage to one area does not obliterate all musical processing. The loss of ability will depend on the location of the affected area. Maurice Ravel was known to suffer from cerebral degeneration but it only affected his ability to write music. He could still play compositions, exercises and scales. His frustration came from the fact that he had a finished opera in his head, but could never have it performed due to his inability to put it on paper. The Russian composer Vissarion Shebalin lost all ability to communicate except through his music. Although he suffered with several strokes, he continued to write until he died, ten years later. His fifth and last symphony was considered by many to be his finest work. (Weinberger, 1) So, even though speech and music overlap with regard to certain brain processes, the loss of one ability does not always result in the disappearance of the other.

Functional imaging studies have been done specifically using musicians as participants. Researchers noted which parts of the brain were activated when ten musicians listened to and then played scales. While listening, Wernicke's area on the left, and both sides of the auditory cortex, were stimulated. When they were asked to play the scales on piano, areas of the right cerebellum and the left frontal lobe were stimulated. The act of playing also involved the left premotor cortex. When musicians were asked to read a score, without singing or using an instrument, both sides of the occipital lobe and the left side of the parietal lobe were activated. The parietal lobe aids in spatial processing as the notes are interpreted on the page. When they listened to the score and read it simultaneously, the supramarginal gyrus was activated on both sides. This section of the brain helps make the connection between what we see and what we hear. (Sergent, et al.1992) (Wallin, 201).

Another study using musicians shows that there are correlations between what we hear and what we imagine. W. Chen, T. Kato, X. Zhu, G. Adriany and K. Ugurbil in their study, "Functional Mapping of Human Brain During Music Imagery Process," found that the same structures are stimulated in the brain when imagining music as when listening to it. (205) Imagining music also stimulated the putamen on the left side. The putamen is located caudal (to the back) and lateral (on the side) to the caudate nucleus.

The putamen has an important role as part of a larger cluster of structures, the basal ganglia, which affects motor activity including speech and body movements. It also affects our ability to inhibit motor reactions to stimuli or release us from inhibition. This is accomplished via substances called neurotransmitters including acetylcholine and dopamine. (Bhatnagar, 255-256) Parkinson's patients suffer from problems with the basal ganglia so movement becomes inhibited due to lack of dopamine. The basal ganglia also aid in the ability of musicians to play long, smooth connected lines on the piano or sensitive bowing on the violin. So this section of the brain is involved in how we respond to, and participate in, music. (Jourdain, 212)

The motor cortex, sensory cortex, visual cortex and prefrontal cortex are associated with music as well. The motor cortex is associated with our ability to respond physically to music. It is involved in dance, foot tapping and with our ability to play an instrument. The sensory cortex receives feedback from these motor activities and the visual cortex is used to read music. The cerebellum also participates with our ability to move and play instruments. The prefrontal cortex is associated with the concept of expectation and violation, which I will refer to on page 47.

The limbic system is the seat of emotions, sensations and feelings. This system is influenced by music which in turn affects our emotions. In order to have a complete explanation of the sound-feeling phenomenon, a discussion of the limbic system is necessary. The brain's limbic system includes the limbic lobe, the diencephalon, the septum, and the midbrain. The limbic lobe is made up of the sub-callosal gyrus, the cingulate gyrus, the parahippocampal gyrus, the isthmus, the hippocampus, the olfactory cortex, the uncus and the amygdala. This network communicates back and forth with other parts of the brain such as the thalamus, hypothalamus and midbrain. The limbic system is responsible for emotional reactions necessary for survival including the fight or flight response, eating and mating. Afferent (a directional term meaning moving toward the central nervous system) and efferent (moving away from the central nervous system) fibers allow information to pass between structures within the brain and between the brain and the peripheral nervous system. Information comes in from the sensory organs and reactions go back out. (Bhatangar, 322-323)

One part of the limbic system directly associated with our emotional responses to musical stimuli is the amygdala. This area of the brain receives information from the thalamus and measures emotional impact. It then sends information to the hypothalamus as part of the sympathetic nervous system. Impulses are also sent to the reticular nucleus, which affect our reflexes, the trigeminal nerve, facial nerves resulting in facial expressions. The amygdala is involved in responses including 1) dilation of the pupils, 2) hair erection, 3) the secretion of pituitary hormones, and 4) the regulation of blood pressure and heart rate. (Bhatnagar, 323-324) The emotions of rage, fear and punishment are also linked to this area of the brain. It communicates with the laterodiral tegmental nucleus, which results in the secretion of dopamine, norepinephrine and epinephrine. The amygdala is also associated with the storage of memories pertaining to emotional events. Studies have shown that highly emotional events stimulate the amygdala and that stimulation results in a long term memory of the event. Therefore if a person is extremely moved by a beautiful piece of music, the amygdala is partially responsible for their ability to recall it.

As part of the limbic system, the hypothalamus provides substrates for regulating motivation and emotion. It is connected to the cerebral cortex, the thalamus and the midbrain and receives important emotional information from the amygdala. The hypothalamus is involved with the sympathetic and parasympathetic nervous system. It can also affect body temperature, respiration, heart rate, and blood pressure. Stimulating some parts of the hypothalamus can result in expressions of fear, terror and panic. The hypothalamus, in turn, stimulates the pituitary gland, which releases hormones and neurotransmitters. (Described on page 33) Candace Pert refers to the hypothalamic-pituitary-adrenal axis as a chain of events taking place when the hypothalamus is triggered. When this happens hypothalamic axons secrete a neuropeptide called CRF (cortical releasing factor) which, in turn, stimulates the pituitary gland to release ACTH (adrenocorticotropic hormone), which travels to the adrenals causing an exciting rush of adrenaline. (Pert, 269)

The hippocampus is associated with our experiences and how we remember them. It is integrated with what Jourdain refers to as a "temporal lobe categorization apparatus." This is important to our processing of music because it has to do with how the brain groups similar experiences together to create memories. When we hear a particular piece of music, the triggering of these memories can cause emotion. (Jourdain, 311) The hippocampus is located beneath the hippocampal gyrus in the ventromedial temporal lobe. It communicates with both the amygdala and the hypothalamus. (Bhatnagar, 324) Both short term and long term memory are involved in processing music. The frontal lobe is responsible for working memory and the hippocampus deals with long term memory. When we are listening to a piece of music, whether it is a short popular song or an hour long symphony, our ability to remember what we have heard affects our enjoyment. Pieces that are “catchy” or that repeat a main theme tend to stick with us. Our ability to recall a piece is part of the sound-emotion phenomenon. Most people have a certain song which stimulates memories and transports them to another place and time. Even a few measures can create a rush of nostalgia and intense feeling. Whether the feeling is happy or unhappy depends upon the context in which the song became memorable. There are different kinds of memories. We have both semantic and episodic memories. Semantic memories are those attached to a specific meaning. Episodic memories area linked to a particular episode. Jourdain gives an example. Knowing that frogs are slimy is a semantic memory; remembering the time that someone put a frog in your bed is an episodic memory. (Jourdain, 168) With relation to music, knowing that a piece of music is especially beautiful can be a semantic memory and can produce a positive emotion based on its beauty. Knowing a piece of music is beautiful because it was played at a wedding is an episodic memory because it is tied to the wedding and the emotion attached to that event. Both of these types of memories are important to the sound-emotion phenomenon because we often have powerful emotional reactions to pieces of music from our past. Our ability to store and retrieve this information for years is a truly amazing phenomenon. When a person feels overwhelmed by emotion while listening to a piece of music, it could be that there is a memory or association attached to it that is being recreated by the hippocampus.

Blood and Zatorre did an interesting study involving the feeling of "chills" while listening to a piece of music. The test participants were ten McGill University students who had musical training. They were asked to listen to pieces of classical music and rate their level of emotional intensity on a scale from zero to ten, with zero being the least intense. The participants were monitored via PET scan. Their heart rate, nerve impulses, respiration and skin temperature were also monitored. The results showed that the chill factor was the greatest during the piece of classical music chosen by the subject. The results were the lowest when they were listening to the "control" piece. This corresponds with the phenomenon discussed earlier regarding memory retrieval. The results showed significant activity in the amygdala and the hippocampus during chills. This is in keeping with what we know about these structures and their role and their association to emotion and our fight or flight response. They found that music stimulates the same reward and emotion systems in the brain associated with biologic needs such as food, sex, and the feelings induced by the use of recreational drugs. They conclude, "The ability of music to induce such intense pleasure and its putative stimulation of endogenous reward systems suggests that, although music may not be imperative for the survival of the human species, it may indeed be of significant benefit to our mental and physical well-being." (Blood, 11823) Humans can live without music but it would be quite a loss, in my opinion.

Several specific areas of the brain are involved in the processing of music. These areas work in concert to analyze what we hear and allow us to use our sense of sound to organize sounds so that they make sense. These areas also communicate with the systems of the body that are responsible for physical and emotional reactions. This inter-connectivity is key to understanding emotional responses to music.

# CHAPTER FIVE

I have offered discussion regarding the neuroanatomical processes that take place in response to music. I will turn the discussion now to the neurochemical events that occur. Radocy stated that "without psychoacoustical phenomena that translate physical phenomena into conscious sensations, music as we know it would not exist." (93) In other words, what we hear becomes what we feel physically and mentally. How do aural stimuli create the feeling of excitement or pleasure? In this chapter I will examine the way that neurotransmitters in the brain influence our emotional reaction to music.

Neurotransmitters are chemical substances that regulate certain brain activities. They influence language, cognition, hearing, speech, memory, attention, personality, motivation and mood. Because they influence all these areas, they are clearly connected to the effect of music. Some neurotransmitters are more directly involved than others so I will discuss them more extensively.

Neurotransmitters transmit information across neurons at the point of synapse. They can be divided in to small molecule transmitters and large molecule transmitters. Acetylcholine, dopamine, norepinephrine, serotonin, and gamma – aminobutyric acid (GABA) are small molecule neurotransmitters. (Bhatnagar, 135) I will discuss large molecular neurotransmitters (peptides) on page 37.

Let us examine how the process takes place. When the information is sent to part of the brain within the cortex, it then enters the thalamus which is the "receiving station" for our senses and a key part of the limbic system. (Restak, 16) The information can then be sent to the brain stem which controls the autonomic nervous system. The information is sent to other parts of the brain via neurons or brain cells. Neurons, composed of the soma, the axon, the dendrite and the synapse transmit impulses through chemical channels; sodium, potassium, calcium and chloride. (Restack, 19) Neurons also contain over a million receptors that take in messages. Once the information is received by the receptor, the neurotransmitter allows it to bind with the cell and influence it either by excitation or inhibition. There are certain neurotransmitters for certain receptors, for example, it is the opiate receptor which receives endorphins. (Pert, 24) Once the parts of the brain that produce endorphins are stimulated, they release them to circulate throughout the brain. Endorphins act as the body's natural morphine.

In the peripheral nervous system, acetylcholine is the most prominent neuro-transmitter. It also plays an important role in the central nervous system. It is present in the basal forebrain, the brainstem and at myoneural junction. Problems pertaining to this neurotransmitter are linked to myasthenia gravis and Alzheimer's, conditions relating to muscle control and memory. Acetylcholine is key to the sound- emotion phenomenon because it influences the motor fibers of the cranial and spinal nerves. (Bhatnagar, 137)

Dopamine is secreted in the brainstem and the forebrain. There are several studies specifically connecting dopamine with our responses to music. Studies involving rats showed that this area, when stimulated by electrodes, produces great pleasure. The rats learned to press a lever to receive the stimulation and often neglected to eat or drink. Levitin and Menon found that the nucleus accumbens was also associated with our emotional responses to music due to the regulation of dopamine levels. (Levitin, 175) The nucleus accumbens (NAc) is located to the rostral side of the caudate nucleus and to the anterior of the putamen. This nucleus is involved in pleasure, reward and addiction. It produces the neurotransmitter GABA. Addictive drugs such as cocaine and amphetamines affect the nucleus accumbens by increasing levels of dopamine. They also found significant indications that the ventral tegmental area (VTA) was key to the response in the NAc. They referred to this interaction as the mesolimbic dopaminergic pathway. This pathway also involves the hypothalamus. They reported that "tightly coupled interactions in a tripartite network involving the NAc, VTA, and the hypothalamus may serve to mediate brain responses to the reward and affective aspects of music." (Levitin/Menon, 181) This study helps to illuminate important physiological reasons for why music affects us as it does. (182)

Norepinephrine is found in the reticular activating formation and in parts of the autonomic nervous system. It affects our ability to regulate sleep, to focus attention and it also affects mood.

Serotonin is found in the brain stem and in structures of the limbic system. This also helps us regulate our sleep patterns and aids the brain in reducing the sensation of pain. It regulates arousal and affects our emotions. People who are depressed or suicidal have low levels of serotonin.

GABA or y- aminobutyric acid plays a large role in the function of the central nervous system. This neurotransmitter inhibits synaptic events in the central nervous system. (Bhatnagar, 138) It is evident that neurotransmitters play a large role in the chemical functioning of the brain. Because many of them also are related to mood and emotion, it follows that music can either stimulate or inhibit their secretion. Recently, "new age" music and Gregorian chant have been associated with this soothing, stress relieving effect.

Peptides are also important to maintain the chemical balance in the brain. They are large molecular chemicals. Enkephalin, endorphins and substance P are examples of peptides. Enkephalin and substance P are associated with the basal ganglia. (Bhatnagar, 260) Endorphins are pain-relieving chemicals that are produced naturally in the body. They function to block the transmission of pain neurotransmitters at opiate receptor areas of the spinal cord. In other words, they interfere with pain messages that are being sent to the nervous system, thereby causing a feeling of wellness. If endorphins enter the brain when there is no pain present the result is euphoria. The addictiveness of morphine is due to this euphoric feeling involving opiates. (Jourdain, 317) Candace Pert did a great deal of research with regard to the opiate receptor. She found that the areas of the brain connected to the limbic system, particularly the amygdala, contained a large amount of opiate receptors. The opiate receptor can only receive messages or ligands from opiates such as endorphins and chemicals like morphine or valium. If music has been found to stimulate the release of endorphins, it stands to reason that is must also affect these opiate receptors, therefore could have a pain reducing effect upon the listener. (Pert, 24) Jourdain cites a study in which two groups of subjects were asked to listen to music. One group was given a placebo and the other group was given Naloxone, a drug which is us to block opiate receptors in the brain. The Naloxone group experienced less pleasure while listening to the music. (Jourdain, 327) Opiate receptors, therefore, play a large role in our ability to enjoy music. In *Molecules of Emotion*, Candace Pert writes, "Neuropeptides and their receptors thus join the brain, glands and immune system in a network of communication between brain and body, probably representing the biochemical substrates of emotion." (179) Without the presence of key neurotransmitters one has to wonder if music would affect us at all. Music clearly has an effect on the brain at the cellular level and has done so for thousands of years.

Even before ancient times, humans have been aware of the tremendous power of music. Prehistoric tribes used music to prepare the hunters for the hunt, the warriors for the war. The Greeks used music specifically to produce desired mental states. Phrygian (mode whose starting pitch is E) music, for example, was used to prepare men for battle. Lydian (mode starting on F) music was used for serious or solemn religious occasions. "Plato banned all music except Lydian from his Academy in recognition of music's power to degrade rational minds and subvert social order." (Wallin, 422) The Ionian mode (C major scale) was used during joyful celebrations. (Wallin, 418) Although they lacked the scientific information as to how specific neurotransmitters mediated their behavior and mental processing, it is clear that throughout history people were consciously aware that music affected their emotions.

## CHAPTER SIX

I have discussed the sound-emotion phenomenon from the neurophysiological point of view, now it is important to examine the concept from the musical side. How do we define music, and how do musicians create it? Edgard Varese once said that "Music is organized sound" (Levitin, 14) John Blacking, in his book, *How Musical is Man*, extends that definition to, "Music is humanly organized sound" (10). Using the tools that musicians have defined and redefined over centuries, we continue to organize sound in much the same way. When a musician creates a piece of music they draw from the raw materials of notes, groups of notes, rhythms etc. and meld them together. Jazz musicians, for example, can take a simple chord progression (I, IV, I, V, I) and create an entire piece on the spot. Many people like to think that improvisation is a modern idea, however Bach was famous for improvising while playing. So, although new compositional techniques continue to appear, certain musical tools have, for the most part, remained constant. Rhythm, tempo, melody, harmony, tonality, dynamics and timbre are all involved in the process of music-making and are used by musicians of all different cultures to specifically organize sound producing the desired end result; a piece of music.

Violinist Yehundi Menuhim wrote, "Music creates order out of chaos; for rhythm imposes unanimity upon the divergent; melody imposes continuity upon the disjointed, and harmony imposes compatibility upon the incongruous." (Storr, 33) Rhythm is the primal ingredient in music. Even before we are born, the sound of our mother's heart beat is part of our awareness. A continuous rhythmic pulse pervades our senses. Rhythm is everywhere in our lives. Jourdain explains that there is a kind of rhythm generated in our daily lives. He calls it "the rhythm of organic movement." There is a rhythm to the way we walk, run, and play sports. Nature has a rhythm as well. Jourdain refers to the rhythm of "cascading water and the howling wind, the rhythm of the soaring swallow and the leaping tiger". (123) There is rhythm in the waves on the beach, the lunar cycle and the sunrise and set. Our breathing is rhythmic. Normal humans take between twelve to twenty breaths in sixty seconds. (Campbell, 66) Rhythm is a universal in all music and exists in all cultures. John Blacking found, in his research of the Venda tribe of Northern Transvaal, Africa, that their music is based on a "rhythmical stirring of the whole body" which transports the players, dancers and singers to the spirit world. (Blacking, 27) It is also representative of the rhythmical cycles of life. Through their music and dance we see the rhythmic patterns of birth/death, maturity/marriage, arousal/release as well as the menstrual cycle of young women. In Hindustani music, the Tala is the classical system of rhythm. Talas are rhythmic cycles or groups of beats. Cycles can be long or short and are divided by hand waves or claps and could be considered similar to our measures. (Ruckert, 40) Because much of their music is used in worship, the rhythms follow speech patterns. Singing and playing rhythm instruments is a vital part of Hindu worship and religious practice. Legend states that the Great Lord Shiva himself played the Tabla, the primary drum of Northern India. (Ruckert, 50)

In Western music, rhythm is the pulse over which the other musical aspects are built. This pulse is recurring and extends over time. Our ears are attuned to following the pulse of the piece from beginning to end with an expectation of predictability. (Levitin, 165) Rhythm, and more specifically meter, organizes these pulses and provides a system for accurate recreation or reproduction of a piece. It groups sounds into sets of two, threes, fours, sixes and so on, creating order. Order aids the brain in processing what it hears. "Rhythmic markers", allow the brain to process incoming information without becoming overwhelmed by multiple observations. (Jourdain, 124) Rhythm helps the brain identify patterns in the music and make sense of the piece as it expands over a set period of time. Musicians manipulate this tendency by altering the rhythm within a piece to create differing effects. In their writing, they often set up an expectation; they work against it to create tension. A piece with very consistent rhythm can create a feeling of predictability and stability, whereas a piece of music with no consistent rhythm, like Gregorian chant, can frustrate our desire for a steady, predictable beat. Very syncopated music, like ragtime, can produce an unpredictable, unsettled feeling. Polyrhythm (more than one rhythm occurring simultaneously) can seem jarring and foreign to listeners who are unfamiliar with this type of music. Rhythm can also be a great source of emotion, exhilaration and excitement.

Tempo, another central aspect of music, is the term which indicates the speed or rate at which a piece will be played. Tempo is measured in beats per minute, for example, M.M. =80 tells the musician that the piece is meant to be played at a rate of eighty beats per minute. This determination is made by the musician and is often specified at the beginning of a piece. If a piece of music is written for a specific purpose, an appropriate tempo is chosen. A requiem would certainly be played at a different tempo than would a march or dance. The musician considers tempo to be a vital decision in the composition process for it greatly affects the impact of the piece because it often an indicator of mood. Tempo plays an important role in our overall perception of music. "Rhythmic perception also depends on tempo, because the organization of succession into perceptible patterns is largely determined by the law of proximity (Gestalt psychology)." (Radocy, 160) If the tempo is too slow the listener has difficulty maintaining the overall idea and the concept of rhythm and melody are lost. Maintaining the right tempo can affect performance. Choosing the wrong tempo can have disastrous results as the tempo influences the time allowed to play the rhythms as they appear in the measure. Meter determines the mathematical relationship/ ratio between the quarter note and the sixteenth note, as an example. However, the tempo determines the rate of speed at which this ratio should be maintained. Tempo allows for a mental framework and a pattern of predictability. Constant tempos allow the listener to tap a foot in response to the music. An inconsistent or fluctuating tempo can strip away the sense of predictability and affect the psychological impact of the piece.

Tempo can affect how well we actually hear the music and our attention to detail. If a piece is played very quickly, we are likely to let it sonically wash over us, whereas in a slower piece, we are more aware of minute details and delicate nuances. Jourdain writes, "When the flow of information at any level of hierarchy comes to exceed the brain's processing powers, there can be a sudden shift in perception toward larger structures." (143) If a piece is played at a blistering pace the brain cannot process quickly enough to hear the potential of each note. Slight changes in tempo, however, for reasons of emphasis or drama can be very effective. Ritardandos (slowing down) and accelerandos (speeding up) heighten the psychological and emotional impact of the piece without destroying the sense of continuity. Diane Deutsch suggests in her research that we all have our own "spontaneous tempo." Whether we are referring to the speed of our small motor movements or walking, this inner tempo is regulated by the medulla oblongata in the brainstem. (Deutsch, 153)

Musicians create melody via deliberate compositional choices with regard to pitch and duration. The musician decides which pitch will sound and how long it will sound. He or she also decides what tones will follow and in what order. Options are culturally dependent. In Western music, since around 1700, the musician makes pitch choices using notes from the equally tempered scale consisting of the twelve tones that exist within a specific octave. Blacking stresses the need for what he calls "sonic order" which can be deliberate, as in choosing from scale tones, or may be dictated by the capabilities of the available instruments. For example, the musician may have the entire eighty eight keys of the piano to choose from, or the limited range of a violin, thumb piano, ocarina, or sitar. In African Venda music, pentatonic (5 tone), hexatonic (6 tone) and heptatonic (7 tone) scales are used for the basis of composition. Anthony Storr writes, in his book *Music and the Mind,* "Rhythm, melody and harmony are all ways of ordering tones so that they interact and form relationships. These ordered sounds resonate with physical processes in a way which we do not fully understand." (184) The goal of this paper is to work toward this understanding.

In Hindustani music, rags which are pre-set ancient melodies or "melodic formants," are the basis for melodic composition. In the West, we name the scale tones do, re mi, fa, sol, la, ti, and do. In Indian music, musicians use sa, re, ga, ma, pa, dha, ni, and sa, using what we would call a movable do system. (Ruckert, 10)

Melodies represent linear sound, which has both a definite start and end. They are used in music, as sentences are in language, expressing a purposeful idea. Melodies follow a certain contour just as sentences move from noun to verb and back to noun creating moments of climax: highs and lows which affect us emotionally. The melody of a piece is usually presented and then is repeated. Once the melody has been reinforced it sets up an expectation and one expects to hear it throughout the piece. Musicians often thwart our expectation by altering the melody via transposition, fragmentation and other compositional techniques. This creates tension for the listener which is usually resolved by the restating of the original melody at the conclusion of the piece. In his book, *Emotion and Meaning in Music*, Leonard Meyer refers to the "Law of Return" which indicates that once a musical idea has been stated, followed by contrasting material, there is an expectation of a return to the original idea. He writes "The law of return depends for its operation upon 'recurrence,' a form of repetition which must be distinguished from 'reiteration.' There can be a return to a pattern only after there has been something different which was understood as a departure from the pattern, because there is departure and return, recurrence always involves a delay of expectation and subsequent fulfillment." (Meyer 151) In classical music, this pattern is referred to as to ABA, or sonata form which I will explain further on page 56.

If melody is the linear or horizontal aspect of music, harmony is the vertical aspect, giving depth and dimension. Melodies expand sequentially, but harmony represents events that take place simultaneously. The decisions regarding harmony are also deliberate choices made by the musician. The harmonies underlying the melody form the structural basis for the piece and create the tonal gravity that draws the ear from chord to chord. In Western tonal music, the strong pull from dominant to tonic sets up an expectation and usually a sense of completion. (In tonal music the tonic, or I chord, has a strong feeling of rest. Conversely, the dominant, or V chord, emits a feeling of unrest and a need for resolution to the tonic.)

Although many musical principles are universally present in all music, it is important to mention that the tonal system of the West does not function the same way in all cultures. Eastern music, for example might make more use of the sounding of the open fourth or fifth, rather than the third as we are accustomed to hearing. In Hindustani music the sounding of the drone creates an ever present harmonic anchor. In African music, one might not perceive a tonic-dominant progression but more of a representation of relaxation- tension- relaxation. (Blacking, 17)

Psychologically and emotionally we depend on predictable chord progressions for this fulfillment to take place. A musician's ability to manipulate harmonies is important to the overall emotional effect of the music. In *The Classical Style,* Charles Rosen discusses the compositional style of Mozart. He refers to "tonal stability," which means that the listener can trust that, no matter how a musician deviates from the tonic key, resolution will take place. The power of Mozart's pieces lies in his ability to modulate seamlessly and yet fulfill our expectations. Rosen writes, "The unsurpassed stability of Mozart's handling of tonal relations paradoxically contributes to his greatness as a dramatic composer. It enabled him to treat a tonality as a mass, a large area of energy which can encompass and resolve the most contradictory opposing forces." (Rosen, 186) Although we can not credit his music with the ability to raise IQ, his genius as a composer can not be refuted.

Tonal variety acts within a piece of music as does plot development in a novel. It creates interest and conflict, but also expectation. Tonal expectation plays a large role in the aesthetic experience of a piece of music. Emotionally we seek fulfillment of our expectation. Musicians can heighten our emotional state by delaying resolution through the use of half cadences and deceptive cadences. Wagner, for example, often delayed resolution of harmonies to enhance the drama of his music. Much of Leonard Meyer's work in the area of music psychology deals with this idea of expectation. He underscores the emotional importance of expectation or expectancy violation and its effect on the listener. Daniel Levitin discusses Beethoven's "Pathetique" Sonata in his chapter on expectation. He writes. "To delay the resolution- Beethoven was a master of suspense- instead of continuing the descent down to the tonic, Beethoven moves away from it. In writing the jump down from the high B flat to the E flat, Beethoven was pitting two schemas against each other: the schema for resolving to the tonic, and the schema for gap fill. By moving away from the tonic at this point, he is also filling the gap he made by jumping so far down to get to this midpoint. When Beethoven finally brings us home two measures later, it is as sweet a resolution as we've ever heard." (Levitin, 116)

In discussing tonal music, one must understand the concept of dissonance because it is key to the development of tonal tension in music. Simply put, dissonance represents sound against sound. Conversely, consonance is considered sound with sound, or sound combinations that are pleasing to the ear. The consonance/dissonance relationship is crucial to the harmonic power of a piece. A consonant interval or chord is stable; complete and requires no further movement. A dissonant interval or chord is unstable and begs for resolution. The concept of consonance and dissonance affects us psychologically. "For consonance and dissonance are not primarily acoustical phenomena, rather they are human, mental phenomena and as such they depend for their definition upon the psychological laws governing human perception, upon the context in which the perception arises, and upon the learned response patterns which are part of this context." (Meyer, 230) In other words, we have learned though our past musical experiences what to perceive as consonant or dissonant. Perception of dissonance can also be culturally bound. As Westerners, we might perceive Indian music to be quite dissonant but to a native of the country, it is the norm.

Musicians use dissonance in their music to create the emotional reaction that takes place as a result of the brain's processing and analysis of aural stimuli.
Blood, Zatorre, Bermudez and Evans did a study specifically examining the effect of dissonance on the brain and emotions. Much has been written about the positive effects of music, so their study was aimed more at looking at negative responses, exposing test subjects to varying degrees of dissonant music and examining their emotional and neurological reactions via PET scan. The researchers chose subjects who were most likely indoctrinated with western tonal bias yet were not formally or classically trained. Their findings revealed that there are sections of the brain that are peculiar to processing dissonance and differ from those that process consonance. They found that "activity in the right parahippocampal gyrus and precuneus regions correlated with increasing dissonance, whereas activity in orbitofrontal, subcallosal cingulate and frontal polar cortex correlated with decreasing dissonance- equivalent to increasing consonance." (Blood, 383) They also found that the areas of the brain that are associated with emotional responses to music, are not necessarily the same as those involved with other musical processing. They found that activity in paralimbic and neocortical regions was clearly associated with the degree of dissonance presented in the music, and thus begin to identify the neural basis for emotional responses to music.(Blood, 386)

In keeping with the ideas of harmony and dissonance, a discussion of tonality and atonality is appropriate. As I have mentioned, the term tonality refers to how chord progressions are handled traditionally by Western composers between 1650 and 1900. Generally speaking, the music that was written between the Renaissance period and the late nineteenth century was considered tonal. (Not to suggest that tonal music ceased, it did not. Most pop, rock, jazz and even rap music of today can be described as tonal.) The composers of these early eras followed a somewhat prescribed formula for exposition, development and recapitulation. In other words, a musical idea would be presented, altered and then restored. Modulations from one key to a relative key were acceptable and created variety and interest.

At the same time that "unsightly" brush strokes were appearing in modern visual art, new compositional techniques were being brought forth in the music world. The increasing use of chromaticism (movement by half step rather than diatonic step) creates a sense of ambiguity and instability. Music which is chromatic in nature confuses the ear and obscures the tonic. The listener cannot predict the resolution and therefore loses the sense of expectancy. (Meyer, 220) This tendency makes chromaticism a very powerful instrument for affecting emotion. With the music of composers such as Beethoven, and even more so with later composers such as Debussy and Wagner, tonal boundaries were expanded. Bartok, Berg, Webern and Schoenberg disregarded the rules of tonality altogether. New systems were introduced as a means of creating "sonic order" but because our collective ears had been trained by years of western influence, many viewed this as an abomination.

Atonality involves the absence of a tonal center. Atonal music is often written without consideration for chordal progression and hence there is a lack of tonal expectation. I would argue, however, that there can be rhythmic or motivic repetition which aids in expectation. Although not readily apparent to the ear in serial music, there is usually a set structure in place using twelve tones which the musician presents forward, backwards, transposed or inverted. All the notes in the row are considered equal and no one note is emphasized. In the music of Arnold Schoenberg, for example, the emphasis is not how the melody expands with relation to the harmony but more how all the notes move in a spatial continuum. The emphasis is not how the notes sound simultaneously but on the intervals created between the notes. Though the development of serial music was viewed as a step forward in music history and theory, it obliterated any sense of order and predictability for the listener. Clearly, tonality or the lack of it, plays an important role in the emotional effect of music.

Musicians use dynamics to shade the sound and vary the emotional effect of the music. Even the smallest of dynamic changes can have a profound effect on the listener. A comfortable decibel for listening to music in headphones is 75dB. A particularly loud section of a classical concert or opera might be 105 dB. A rock concert might be at the threshold of pain and damage to the inner ear at 250 dB. The dynamic of a piece of music can dramatically affect a person emotionally and physically. When listening to loud music, most people experience a feeling of exhilaration and excitement. It makes the heart beat faster and gets the blood pumping. Campbell insists that the human heartbeat is very sensitive to sound and music. The heart rate responds to frequency, tempo and volume and tends to match the rhythm by speeding up or slowing down. (Campbell, Mozart Effect, 67) Excessive sound can raise a person's blood pressure by up to ten percent. Subconsciously, it can trigger the brain's fight or flight response releasing adrenaline and norepinephrine, both of which accelerate the heart rate and constrict blood vessels. (Campbell, 68) Loud music overwhelms the auditory system making the neurons fire at an unusual rate. "Sensory overload" can alter the brain state and results in the release of certain endorphins in the brain. (Levitin, 69)

The use of dynamic changes for the purposes of emotional effect appears to be universal to music. Loudness or softness is often associated with an extra-musical idea. The dynamic changes in Hindustani music as well as the music of Africa seem to correspond with the text or purpose of the particular piece. Songs of celebration or happiness tend to be louder than pieces of a contemplative or sacred mood. In the "Venda Possession Dance" the volume gradually grows as the dancer comes closer to slipping into a trance. Dynamics have a profound effect on the participants, the singers, the instrumentalists and all who witness the rite. Leonard Meyer makes an excellent statement when he writes, "Both music and life are experienced as dynamic processes of growth and decay, activity and rest, tension and release." (261) It is clear that dynamics create a significant impact on emotion by varying the intensity of music.

Timbre refers to the uniqueness of sound that instruments possess. In 1960, the American Standards Association defined timbre as the following: "Timbre is 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." (Deutsch, 26) Much is determined by exactly how an instrument is played, whether it is struck, blown into, or played with a bow. Timbre is also affected by the materials that an instrument is made from. The tone created by striking at timpani will be very different from the tone produced by striking a bar on a xylophone. The tone is affected by the materials an instrument is made of, the size, the shape and also by the way that the air is set in motion. Individual instruments have different resonance bands or formants, meaning they resonate at particular frequencies. A trombone has only one formant and it lies roughly between 600-800 cycles per second. The main formants of a clarinet boost sound waves between 1,500 and 1,700 cycles per second and 3,700 and 4,300 cycles per second. (Jourdain, 37) Timbre can also be affected by range. The clarinet in the chalumeau register will have a different timbre than in the highest octave of the instrument. The timbre of the low register is deep and reedy, whereas the high register is more thin and nasal. The sound of certain instruments can evoke a particular emotion based on connotation. Over the span of music history, our ears and minds have become indoctrinated as to which instrument connotes which feeling, impression or emotion. For Westerners, the sound of the gong is associated with eastern oriental music, the organ transmits a religious sentiment, and the oboe or English horn emit in pastoral images of the lonely countryside. (Meyer, 259) A military or patriotic feeling is commonly associated with the sound of brass instruments. Armed with this knowledge, the musicians aims to create the perfect combination of tone and timbre to suit the mood of a piece. They can manipulate our emotions and create powerful mental images via timbre choices.

The elements of rhythm, melody, harmony, dynamics and timbre are the tools musicians use to communicate to the listener. Conscious stylistic choices are made and combined to create the voice of the composer. Through the interpretation of symbols on the page we channel the intent of the composer through our fingers, keys, valves and strings. The combination of these elements and the ability of the musicians creates the music which emotionally moves us.

# CHAPTER SEVEN

So far we have concluded that sound travels through the air and is received by the ear. The vibrations are converted and transmitted to the brain. Several areas of the brain process the information that is received and the result is the release of chemicals which affect emotion. Now we need to look at the impact of these feelings and how they affect our behavior and lives. Let us consider the bigger picture and pose these four questions: Why do we respond to music the way we do? Where does the meaning lie? What effect does music have on our bodies and our immune systems? How does music manipulate and motivate us?

We respond to music the way we do partially due to association. Each person brings to the listening process a storehouse of both conscious and unconscious connotation. A newborn baby will not react to a slow, lamenting melody with cries of sadness because it has not made the association between its own feelings and musical stimuli. A baby will react to the sound of its mother's voice. In utero, this voice along with the heartbeat, became the first experience of sound. After birth, the child instinctively recognizes this sound and begins to associate it with warmth and nourishment. As we grow, we make connections between music and experiences that are deeply personal. Our culture has a large impact on these experiences. These are the "colored glasses" with which we view things that affect us. "The listener brings to the act of perception definite beliefs in the affective power of music. Even before the first sound is heard, these beliefs activate dispositions to respond in an emotional way, bringing expectant ideo-motor sets into play. And it seems more reasonable to suppose that the physiological changes observed are a response to the listener's mental set rather than to assume that tone as such can, in some mysterious way bring these changes about directly." (Meyers, 11) I would argue that pre-set mental beliefs can affect our response to music but we can also respond emotionally to music without them. Children, for example, respond instinctively to music, without any predisposition or prior exposure.

Musical association can also be used to explain the phenomenon of preference. People with differing mental sets and musical associations will respond emotionally to different music. Experiential association can also cause the listener to dislike a piece of music. If a negative association or event is attached to a piece (for example, militant music associated with Nazi Germany) the listener will respond accordingly. It was once believed that the interval of the tritone was associated with the devil. So certain intervals can cause uneasiness.

There are several ways that musical preference can be influenced. It usually depends on our personal experiences with music. If we have experienced a certain kind of music within a positive environment, or we have been told by someone whom we trust that the music is "good", we tend to develop that attitude. Different personality traits can affect musical preference. People who are considered "upbeat" might prefer a similar style of music. Group tendencies and cultural experiences affect musical preference. Patriotic music evokes a collective feeling, as does country western, rock music, etc. Our culture affects preference. Ethnic music similarly causes a likelihood of preference in people of a certain ethnic background. School age children are highly affected by the musical preferences of their peers. Musical preference can also change. Exposure to a varied repertoire of music can change and expand musical preference. People respond positively to the music which fits their personal preference and music which is familiar or meets their expectations. (Radocy, 379)

When music has a powerful effect on the listener, it is often due to the elements of expectation and violation. An expectation is set up in the music and then it is violated. "These violations can occur in any domain - pitch, timbre, contour, rhythm, tempo and so on- but occur they must. Music is organized sound, but the organization has to involve some element of the unexpected or it is emotionally flat and robotic."(Levitin, 169)
I referred earlier to Beethoven's Pathetique and the way that he delays the listener's gratification by moving away from the tonic instead of toward it. In listening to classical music, we have been trained to expect 1) the exposition, 2) the development and 3) the recapitulation. In other words, there is the main idea, the conflict/ contrast or movement away from the main idea, and the reiteration of the main idea. The recapitulation is our musical "happy ever after" and the realization of our expectation. When the recapitulation becomes an extended coda, containing new ideas, our expectation is violated. In the recapitulation, one yearns to hear the restatement of the initial thematic material and the return to the tonic key. "For composers and performers alike, music-making is always a tug-of-war between the maintenance of underlying musical structure and the indulgence of musical deviation."(Jourdain, 312) This could be considered like a musical yin and yang.

By fulfilling our expectation, the music causes a positive response for the listener but music can affect the listener negatively also. I have already discussed the concepts of unresolved dissonance, delayed cadences and musical preference. I have also mentioned that atonal music often confuses and irritates people due to a lack of a tonal center. Music with very little repetition can also frustrate the listener by not providing the brain with a recognizable phrase or rhythmic marker. "Through-composed" music, for example, continues to move forward without any repetition or reference to what has gone before. In his paper, "Music and Emotion: Distinction and Uncertainty", L.B. Meyer insists that when the listener is able to maintain a sense of control and he can "envisage with confidence"- the experience will be positive. (341) Extreme uncertainty creates a lack of confidence. Of course, sad, violent or upsetting lyrics can also lead to a negative reaction. Christmas music can cause feelings of inspiration, excitement and happiness but it can conjure up feelings of deep sadness, nostalgia, loss and loneliness. A piece of music associated with a departed loved one can rekindle feelings of mourning.

Music can affect us positively or negatively just like any other aesthetic work of art. Where does the meaning lie? There are several theories regarding the aesthetics of music. Absolutists state that the meaning is a direct result of the musical sounds themselves. Referentialists believe that music can reflect extra-musical ideas. Formalists contend that the meaning of music has to do with the intellectual structure of the music, whereas expressionists see the value of the emotions that are produced by the music. (Radocy, 336) I cannot argue with any of these theories. A piece of music by Debussy would make me inclined to agree with the absolutist or expressionist view because of the way that he manipulates the notes to create a desired effect on the listener. A piece of music by Schoenberg would pull me more toward the formalist view because of the importance he places on the mechanics of the twelve tone row. Similarly, *Un Bel Di* from Madame Butterfly convinces me of the referentialist view because the words convey her deep sense of longing for the one she loves who is off at war. Any one of these, or all of these can apply, in my opinion.

How does music affect our bodies and our immune systems? As I have discussed previously, our perception of music can have a profound effect on all the systems of the body. Don Campbell puts forth in *The Mozart Effect* his theories on the ability of music to heal. He refers to the patients of Dr. Alfred Tomatis, several of whom experienced profound physical/mental/emotional improvements after listening to Mozart. It is interesting to note that ten years earlier, Campbell included a chapter in his book, *Music: Physician For Times to Come,* where Manfred Clynes writes "A word of caution is appropriate when considering the possible healing powers of music. Mozart died at the age of thirty-five, Schubert at thirty-one and Beethoven died before his fifty-seventh birthday. Obviously there are some conditions that even the best music does not heal." (Campbell, 134) I would respond to Mr. Clynes rather "tongue and cheek" comment with a question as to his definition of healing. The act of healing, in my opinion is not limited to the physical body.

Research has shown, however, that emotional experiences, including those connected to music, strengthen the immune system. It had been widely thought that the immune system operated independently of the other systems in the body, but it is now known that this is not the case. David Felten first looked at the spleen and its connection to the immune system. He concluded that there were specific nerve fibers in the spleen associated with immunity. Nerves are connected to every organ associated with the immune system and therefore there is a direct connection with the brain. (Moyers, 225) Similarly, Dr. Robert Ader, who worked in the field of psychoneuroimmunology, showed from his research with rats that the immune system can be conditioned clearly demonstrating that the immune system is not separate from the brain but can indeed be influenced by it. (Pert, 17) Candace Pert insists that "the molecules of emotion run every system in our body, and how this communication system is in effect a demonstration of the bodymind's intelligence, an intelligence wise enough to seek wellness, and one that can potentially keep us healthy and disease-free without the modern high-tech medical intervention we now rely on."(19) So, if music can cause the release of neurotransmitters and neuropeptides, "the molecules of emotion", it would stand to reason that it must affect the immune system.

Roberto Assagioli, MD writes, "There is no agent so powerful in giving us real rest as true music…it does for the heart and the mind, and also for the body, what sleep does for the body alone." (Campbell, 102) Music has the ability to reduce stress. When people sing as part of a social group it has a positive effect by creating a feeling of belonging. Music can serve as a vehicle for releasing emotions that have been repressed and therefore aids in catharsis. Many feel that music connects them on a spiritual level with a higher power creating a feeling of peace. (Campbell, Physician 135)

How are we manipulated and/or motivated by music? Since the dawn of time, music has been a motivating force in culture. Music motivated the earliest humans to go on the hunt, to go to war, to celebrate its religious rites, and to mourn the dead. Today, music is around us almost all of the time. Many would be shocked to calculate the total hours of listening the average person does in a day. It would be a surprise because it is so much a part of our daily existence that we are no longer aware of it. Almost every minute of television viewing contains music, especially in the advertisements. In the car, at work, in the stores, unobtrusively (and sometimes very annoyingly), it is there. It seems that the only time we are consciously aware that we are listening, is at a concert or performance. As part of a concert, musical, comedy or drama, the music touches us and heightens our involvement in the action on the stage. Without the accompanying "spooky" music, horror films would not have near the impact that they do on movie-goers. In the marketplace, in the workplace, in our places of worship and in the areas where we "play", music motivates us and influences our actions. In the marketplace, quiet, peaceful music relaxes the customers and motivates them to spend more time in the store, and more likely than not, more money. North and Hargreaves state in their study "The Functions of Music in everyday life: Redefining the social in music psychology" that pleasure and arousal are the impetus for music in stores. Arousal causes the consumer to respond positively to being in the environment. The pleasure aspect affects customer behavior. (Radocy, 55) Radocy explains that, music often puts customers or clients in a more positive mood, which leads them to be more likely to make a purchase. (55) In the workplace, music increases productivity by serving as a distraction from repetitive work. Music with a steady, upbeat tempo increases overall energy levels and can increase morale. (Radocy, 51) In churches, synagogues, mosques and temples, music motivates us to pray and connect spiritually with a higher being. In gyms and sports arenas, music increases our endorphin levels, and motivates us to perform physical activities. It can also create a frenzied excitement and group dynamic which is very powerful such as that created in mass religious fervor. Therapists use music to connect with mental patients or those suffering from neurological trauma. It can also provide the impetus for meaningful movement/ interaction and/or dialogue while exercising.

Advertisers who use popular, highly exciting music in their ads can increase overall sales. In the December 2004 edition of the *Automotive News*, Jamie LaReau wrote an article entitled "Music is Key to Carmaker's Marketing". She specifically referred to General Motor's use of Led Zeppelin's music to market the Cadillac and the use of Aerosmith's "Dream On" to interest buyers of the Buick LaCrossse. Jimi Hendrix's electric guitar rendition of the National Anthem was used effectively to sell the 2005 Ford Mustang. (LaReau, 22) LaReau quotes the president of Lowe and Partners Worldwide (marketer of the Saab automobile) as stating that music that is recognizable can generate strong emotion and feelings. Martin Lindstrom, the author of "BRANDsense" says that marketers often successfully use the five senses, particularly sight and sound, to market an item. (22) He specifically states that sound and a strong beat influence decision making. LaReau continues to explain that specific genres are used to target certain age groups. Classical music is aimed at those over fifty. Ford specifically uses country music to encourage the sale of F-150 trucks and alternative music is often used to target the twenty-four to thirty-five age group. (22)

It has been clearly documented that music has a powerful positive effect, however music has also been used to motivate us in a negative and destructive way. Allan Bloom expressed his concerns about this in his book "The Closing of the American Mind." Although a few of his thoughts were controversial, his opinions on rock music and its negative effects on students cannot easily be disputed. (Storr, 45) Rock concerts have become increasingly dangerous through the years. If you take in to consideration the decibel level alone, there is cause for concern. A portion of today's rock music contains violent, obscene and highly negative implications. Themes of suicide and death pervade the lyrics. Highly provocative sexual language is prevalent along with language that demeans women and/or racial groups. The combination of extreme stimuli via volume, rhythm and the highly charged subject matter, is a vehicle for potential disaster. "Mosh pits" and overcrowded concerts lend themselves to dangerous and inappropriate group behaviors. "Group-think" is a well-explored phenomenon. Of more concern are the attitudes and emotions that are being pounded literally into young developing minds. Over the years there has been much speculation as to the use of subliminal messages imbedded into pieces of music. People speculated about the existence of subliminals in the music of the Beatles. Clearly music can motivate for evil as well as for good.

As I mentioned earlier, music is being used as a motivator to increase learning abilities in school age children. Whether or not there is any validity to the ideas surrounding The Mozart Effect, music is often used as a tool to enhance non-musical learning. Music can be used as a reward for completing an assignment or it can be used as part of the learning process. Setting rote information to a rap rhythm for example, can aid memorization. (Radocy, 76) Other studies show that, although not backed by large research sampling, music can have a positive effect on academic achievement. Given what we know about the correlation between shared brain processes for music and language, it is not surprising that researchers found that music influenced language development, speech and reading acuity. Researchers have also looked into how music affects mathematics, creativity and social development. They have been very cautious of making any broad claims. One indisputable conclusion exists, and that is that quality musical training increases musical ability and appreciation.

Music affects us all in a very personal way. It affects our minds and our bodies. It affects our attitudes and can change our body chemistry. It can motivate us to cry or to be joyful. The music we listen to is a deeply private choice but it can also be a powerful societal force. It can connect us to our humanity but also transport us outside ourselves to commune with a higher being. Music can connect us through our culture to our progenitors and future generations. Moving molecules of air enter our bodies and minds and, through an amazing series of processes, are interpreted by the brain to have meaning. Composers and musicians manipulate the creation of these molecular streams to project their intent. Inside the sophisticated web of cranial structures, the aural information is transformed to chemicals that make us feel good. The effect of music has pervaded human existence since the beginning of time and will undoubtedly continue to do so. Through the advances in technology, it may become possible in the future to pinpoint the exact avenues that music changes us. For now, we can just appreciate that it does. As Josiah Booth eloquently stated, "Music is the language of feeling. We, none of us know, or speak it, in its full perfection as yet. An earnest endeavor to attain some richer appreciation of its charms, or to acquire some higher power in the expression of its meaning will undoubtedly bring with it a reward of inestimable worth. Exalt art and art with exalt you." (Davies, 1)

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