Classical music and the brain

Abstract

This paper explores the relationship between classical/baroque music, and the regulation of brain waves/activity. Various researchers have conducted vast studies in association with how the human brain reacts to music. The purpose of this paper is to explore the causation of the positive effects classical music has been discovered to have on the human brain. It appears classical music may promote positive effects such as: stress reduction, increased dopamine secretion, increased memory and concentration, supercharging the brain, pain relief and aid in fighting depression. Baroque music is a definition of a classical music era that occurred from approximately 1600 to 1750. The word Baroque stems from the Italian word *barocco* whichtranslates to bizarre. The pioneers from the Baroque period include the following composers: Johann Sebastian Bach, Antonio Vivaldi, George Frederic Handel, Henry Purcell, Claudio Monteverdi, Heinrich Schutz, Domenico Scarlatti and Jean-Phillippe Rameau (CMUSE, 2018). Research conducted on Baroque music has discovered that some of the direct effects of the music have caused a decrease of beat waves by six percent as well as an increase of alpha waves by six percent. The same research had also discovered that Baroque music synchronizes the right and left hemispheres of the brain. Baroque music in line with 50 to 70 beats/minute is excellent for increased enhancing learning efficiency. The effect on learning efficiency is reflected on the brain α-wave.

Keywords: Baroque music, Classical music

Classical Music and the Brain

When a human being listens to music, the body and the brain undertake complex actions to facilitate the sound waves into what we interpret as music. Sound waves enter the ear and travel down the ear canal which vibrates the eardrum. The sound waves vibrate the eardrum; the vibrations are sent to three small bones: malleus, incus and stapes which are all located in the middle ear. The bones then increase or amplify the sound and the sounds then travel to the cochlea. The cochlea is filled with fluid and located in the inner ear. The cochlea is divided into an upper and lower portion by an elastic membrane known as the basilar membrane. Once the auditory vibrations reach the cochlea, the vibrations cause the fluid located inside the cochlea to move and a wave forms along the basilar membrane. Vestibular cells also known as hair cells are located on top of the basilar membrane; the hair cells react to the movement of the fluid (VanPutte, Regan, & Russo, 2019). Vestibular cells located at the wide end of the cochlea detect higher-pitched sounds and the vestibular cells located in the center detect lower-pitched sounds. As the vestibular cells move; stereocilia located on the top of the cells bump against the structure and bend. The bending causes channels located on the top of the stereocilia to open. Once the channels are open, chemicals enter the cells and create an electrical signal. The auditory nerve transmits the signal to the auditory cortex located in the temporal lobe of the brain; the brain then turns the signal into a sound that can be understood and recognized. (VanPutte, Regan, & Russo, 2019).

All sounds, including music are processed in the ascending auditory pathway to the auditory cortex (Castillo-Perez, et al., 2010). Functionalmagnetic resonance imaging(fMRI) and position emission tomography (PET) scans provided validation to researchers that the planum temporale is an auditory association area that processes both auditory stimuli. The response to music and the physiological connectivity of the mesolimbic system has been shown to reflect pleasurable experiences. Several research studies have been conducted while utilizing Mozart's Sonata for two pianos in D major K. 448. The sonata has been associated with the " Mozart Effect" which has been proven to enhance brain sufficiency by activating several signal pathways within the brain. (Castillo-Perez, et al., 2010).

Studies utilizing magnetic resonance imaging (MRI), functional magnetic resonance fMRI and PET scans have reflected that nerve networks in various parts of the brain are responsible for interpreting various properties of music (Harvard, 2011). It was discovered that a small area in the right temporal lobe detects pitch, another area in the right temporal lobe decodes timbre; which allows the brain to distinguish between different instruments that are playing the same note. The cerebellum processes rhythm and the frontal lobes interpret the emotional content of the music (Harvard, 2011). Utilizing an fMRI, researchers were able to watch the brain in action while study participants were listening to music in a concert setting. The participants were told to allow their attention to wander. Researchers noted that during the transition point of the music (when the music pauses for a moment) the participants attention halted. This was evidencing the brain extracts information, and places the information in order: beginning, middle and end without requiring thought (Baker, 2007).

In a 2015 study conducted by Helsingin Yilopisto at the University of Helsinki, it was determined that listening to classical music affected gene expression in the profiles of musically experienced participants involved in the study. Reportedly, listening to classical music enhanced the activity of genes involved in the following: learning and memory, synaptic function, dopamine secretion and transport (Yliopisto, 2015). Furthermore, it was discovered that listening to music may have assisted with decreased activity of the genes that are associated with neurodegeneration. All the participants involved in the study listened to W. A. Mozart's violin concert Nr 3, G-major, K. 216 that lasts for twenty minutes. The participants involved in the study were both musically experienced and inexperienced. It should be noted, one of the most up-regulated genes, synuclein-alpha (SNAC) is also known to contribute to song learning in songbirds(Yliopisto, 2015). However, it should be noted that the effect of decreased down-regulated genes was only observed in the musically experienced participants. Researchers felt this suggested the importance of familiarity and experience may produce new information regarding molecular genetic background of music perception and evolution (Yliopisto, 2015).

In November of 2016, researchers from South China Normal University in Guangzhou led by Ping Huang conducted a study that provided evidence that artistic music is of intelligence, while popular music is of physiology. The study found that classical music caused increased levels of arousal in the neural network then " popular" music did in participants. It was discovered classical music elicits a higher level of brain activity/response than simple tunes. An fMRI was utilized to measure the response of the participants neural reaction to the two types of music played and its subsequent reaction. The team created brief musical excerpts (12 to 24 seconds). Half were taken from the opera, others from pop songs. The participants listened to five classical experts, five pop excerpts and seven brief musical notes (Jacobs, 2016). The researchers discovered the different types of music produced different patterns in the brain's reward circuitry. (Huang, 2016). Ping Huang further discovered thatclassical music evoked increased levels of arousal in the neural default network (Jacobs, 2016).

Research and study associated with the effects of classical music and the brain are not unique. In 1993, Psychologist Frances Rauscher discovered that college students who listened to Mozart before tests gained up to ten spatial IQ points. A study performed by the University of Washington's Institute for Learning & Brain Sciences discovered that playing classical music to nine moth old babies led to increased understanding of rhythm in speech and music (" How playing music", 2018). Other studies conducted concerning young children and music discovered that children participating in an interactive music group learning percussion instruments and lullabies reflected earlier and elicited a heightened brain response to music compared to children in the passive music group that played with toys and listened to " Baby Einstein." Young children in the interactive group also showed larger and advanced brain responses to musical tones than those who were in the passive group (" How playing music", 2018).

In 2014, a research paper was published regarding Baroque music's influence on learning efficiency based on the research of brain cognition (Gu et al., 2014). An electroencephalogram (EEG) analysis was conducted on research participants. The EEG's were performed and recorded before and after participants listened to Baroque music(Gu et al., 2014). The researchers specifically targeted the brain’s memory and attention for analyzation. The experiment reflected that Baroque music has a positive influence on improved learning efficiency(Gu et al., 2014). Classical music has many benefits including listening to classical music as background noise which can have a benefit of an increase in mood, productivity and creativity (Neuman, 2016). The following is a list of benefits associated with classical music that have been researched scientifically: decreased blood pressure, fights depression, boosts memory, pain management, increased creativity, reduction of stress, increases dopamine secretion, helps decrease insomnia, improves productivity (Neuman, 2016). Research has also reflected that music may activate neural mechanisms like those previously associated with pleasant or unpleasant emotional states. It was found that slower tempo baroque music can create mentally stimulating environments and increased creativity. Regular classical music was found to increase concentration and memory when the music is playing in the background (Webber, 2008). Interestingly, Mozart’s Sonata K448 for two pianos has been utilized to help treat epilepsy. Research performed has shown patients who have been diagnosed with epilepy have decreased occurrences of seizures when they have been exposed to the sonata on a regular basis (CMUSE, 2018). Neuroscientific research occurring in the field of Neurologic music therapy has discovered a method known as Rhythmic Auditory Stimulation (RAS) which is used in cases associated with gait training. While listening to a set of auditory cues patients are then instructed to time their movements with the perceived rhythms and they quickly gain the ability to their muscular movements (CMUSE, 2018).

In 2018, Harvard medical school staff published finding on how music may help children with autism. The study provided evidence that music therapy may help autistic children increase functioning with the following: social interaction, verbal communication, initiating behavior, and social-emotional reciprocity (Harvard, 2011). Recently, scientists have discovered altered brain connectivity as a key deficit associated with autism. Individuals with autism may display impairment with sensory integration, as well as enhanced attention or bias towards certain objects, numbers, tones, colors, sounds, material and textures(Sharma, Tarazi, 2018). Years of music research has allowed researchers and practitioners to understand that music can change the structure of the brain and the functional connectivity of the cerebral cortex. This in-turn allows for increased sensory integration across cortical and subcortical areas in early development. Music activates the mirror neuron system, which is the aspect of the brain that is responsible for communication, empathy and imagination (Sharma, Tarazi, 2018). A 2009 study conducted using music-based intervention discovered that nonverbal children diagnosed with autism were able to speak after participating in auditory motor mapping training (Sharma, Tarazi, 2018). Researchers have found that music in conjunction with behavioral interventions and prescribed medication has positive effects. Reportedly, fifteen to twenty minutes of exposure to music three times a week has demonstrated clear detectable changes in the brains of children with autism. If a patient engages in thirty to forty-five-minute active music training sessions over a six to eight-week period; profound changes were detected in the areas of the brain associated with speech and hearing (Sharma, Tarazi, 2018). The greatest amount of evidence associated with this study was completed with classical music.

However, researchers note behavioral patterns require consistent practice to create change. Therefore, it is recommended that the child choose the type of music that is used during therapeutic sessions. They also recommend this type of therapy to be utilized at least three days week, with sessions that are no longer then forty-five minutes a day(Sharma, Tarazi, 2018). Clinicians have also discovered that individuals with autism can use music to express emotion. Edward Roth, director and professor of music therapy at Western Michigan University, children placed into an fMRI scanner while listening to someone improvising music or themselves improvising music showed activity in areas of the brain involved with communication. Dr. Roth expressed that one could not tell the difference between individuals interacting with music and individuals who were interacting verbally(Zlatopolsky, 2017). An additional fascinating test involved obtaining blood samples from college students before and after singing both improvised and composed music. The results for improvised music showed a reduction in hormones associated with stress, and an increase in oxytocin. The results for the composed music only showed a reduction in stress hormones. The results reflected that group singing reduces stress and arousal as well as inducing social flow in participants (Zlatopolsky, 2017).

Lastly, I will be discussing the effects of music associated with the brain and depression. Depression is a mood disorder that may result in a loss of social functioning, increased mortality and reduced quality of life. It is estimated that approximately 322 million individuals around the world suffer from clinical depression. Depression is associated with emotional, psychological, physical and social impairments; it can lead to social isolation and loneliness

(Leubner, Hinterberger, 2017). Research conducted by Daniel Leubner and Thilo Hinterberger studies the correlation between music intervention and a potential alternative treatment for depression. The authors of the research placed music therapy into two categories: music therapy and music medicine. Evidence based procedures are used to differentiate between using a song to cheer some one up versus using music to treat an individual's medical symptoms. The groups were divided by age: young, medium, and elderly. The young participants were under thirty years old, young individuals showed minimally better depression score improvements if they attended group, rather than individual music intervention sessions. Individuals in the medium age group were between thirty-one and fifty-nine years of age. Individuals in this group presented better results if they also attended group therapy sessions over individual sessions. The elderly group contained individuals who were sixty years or older. They showed an increase in improvement if they attended individual settings. It should be noted; classical music was the only music selection available for the elderly group. The two other groups also incorporated percussion and Jazz music into their group and individual settings. In the groups that utilized classical or baroque period music; four out of eight studies showed improvements with depression scores (Leubner, Hinterberger, 2017). Groups that utilized percussion music did not find any positive or negative changes associated with the use of this type of music and depression scores. Finally, the groups that used Jazz music had limited data, but all individuals had reflected positive outcomes but, it was impossible to measure the scores due to the data issues(Leubner, Hinterberger, 2017). The authors of the study felt that music did have a positive impact on the groups associated with the study.

They felt music should be considered an emerging treatment option for mood disorders. Research also showed beneficial effects to include: improvement of psychiatric symptoms, awareness, and positive emotions (Leubner, Hinterberger, 2017).

In conclusion, I would like to discuss my personal experiences with music intervention. I began to mediate and listen to classical baroque period music as an alternative for pain management. In 2013, I was involved in a multi-vehicle accident caused by an impaired motorist. My injuries were severe and required surgical intervention and long-term therapy, as a result of the accident I am permanently injured and will remain on medication for the rest of my life. Due to my professional background, I was acutely aware of the dangers associated with prescription pain medication, I only take it when I feel I do not have any other options. I began researching various modalities associated with pain management and I found a lot of research associated with classical music and meditation. I tried both, and the results were amazing. I always have classical music on in the background and I have noticed a reduction in irritability, pain, depression and anxiety. I noticed an increase in my memory, attention, attention to detail and my ability to focus on a task without being distracted. I was hooked, the music uplifted my mood and allowed me to focus on positive aspects of my treatment. Yes, there is so much more to this story, but it would take up too much of our time. Lastly, I began playing classical music to pediatric patients I was treating who have been diagnosed with Attention deficit hyperactivity disorder (ADHD). The results were immediate, the two children, who are treated individually became very calm when the music was played quietly in the background. They sat still for several minutes, which is rare and followed activity instructions without behavioral issues. My supervising therapist was happily shocked by the results she witnessed. When she asked one child if he was enjoying the music he answered yes. The child's mother could hear the music in the front reception area and was shocked her child was responding so well to the music. The parent admitted they were an artistic musical home, but they had never tried listening to classical/baroque style music. Unfortunately, the family has changed insurance and we only saw the child for two additional sessions. However, family did report they were playing classical music in the home and they continued to notice positive changes in his behavior. I was informed he found the music to be soothing and relaxing. That is why I chose this for a topic to research. Personally, and professionally I have seen the positive changes that can occur with the use of classical music.

RESEARCH

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