The Impact of Music on Brain Cells: The Case of Mozart's Music

By: Dr. Rohan Obied

Abstract

Music can improve memory, focus, and learning. Additionally, it can lessen stress, boost physical productivity, and improve general mental fitness. Listening to music can enhance cognition, memory, and learning. Listening to music not only reduces anxiety, blood pressure, and discomfort but also improves mood, sleep patterns, mental acuity, and memory. Music may energise, inspire, or calm and comfort people. This study was designed with the aim of evaluating the impacts of music on the activity and performance of brain cells, considering the Mozart's music case as an interventional approach. The study was designed on the basis of utilizing the secondary qualitative design where content analysis was chosen as an effective data analytical technique as the findings of various studies were observed in in-depth. The findings suggested that listening to Mozart's music can cause feelings of elevated arousal, which temporarily leads to improved performance across a wide range of cognitive areas. More significantly, the brain's rhythmic rhythms and cells are positively impacted.

Keywords: Brain cell, Mozart's music, neuron, human brain cell, learning

1.0 Introduction

Music has been performed for emotional stimulation and therapy for generations. At Asclepius, the Greeks put a sick person in the middle of the arena and use particular sounds to treat those people (Exbrayat & Brun, 2019). It was discovered much later that music had positive effects on brainwave activities in migraine sufferers, as well as in individuals who had a hearing impairment and autism in their early years. It was also reported that music could improve creativity, vocabulary storage, reading comprehension, and learning global languages. Particular musical compositions' influence on human behaviour is frequently attributed to how they affect human emotions and excitement. The effects of listening to music on engagement (the level of physical activation), mood (permanent feelings), and pleasure have an impact on how well listeners do a range of brain activities (Grylls & McLellan, 2018). Furthermore, Ramdinmawii and Mittal (2017) stated that music is a "prelanguage" that could access those intrinsic activation rhythms and boost the cortex's capacity for the prediction process, hence enhancing various major brain activities. Music is a language that could be learned at a young age. This theory was founded on the 'Mozart effect,' which is defined as an improvement in productivity or a shift in brain activities caused by listening to Mozart's music. Furthermore, Gasenzer and Neugebauer (2017) argued in their analysis argued that having listened to a particular kind of music (such as Mozart) strengthens the connections between particular brain regions, making it easier to choose and "connect" together all the necessary components of sensory stimuli into a perceived bigger picture. Furthermore, it can be argued that if a pattern of stimulated brain regions matches the patterns required to complete a task, an improvement in cognitive tasks may occur.

Moreover, the significance of performing this analysis is that no one in the previous researchers performed their assessment specifically on Mozart's music and human brain cells. The findings of the current analysis have contributed to the existing body of knowledge. Furthermore, there is a gap in performing this analysis because many of the

researchers performed their analysis specifically on this topic of Mozart's music before 2016 but one conducted their assessment on this topic after 2016 on recent trends and patterns suggesting that more investigation is required.

- To understand the concept of Mozart's music and human brain cells
- To explore the impact of Mozart's music on human brain cells.
- To identify the influence of Mozart's music on human brain cells in different stages of learning, priming and consolidation.
- To provide recommendations for the different programs for learning Mozart's music based on the result of the study.

2.0 Literature Review

2.1 Mozart's Music

The music of Mozart and Haydn is regarded as the standard for traditional music. When Mozart started to write music, the Galant style heavily dominated European music as a response to the rapidly developing complexity of the period. The early romantic rhythmic complexities gradually emerged, regulated and controlled by new types, as adjusted to a new appearance and social context, mainly due to Mozart itself (Ramdinmawii & Mittal, 2017). Mozart was a creative composer who produced works in all the major genres, such as the piano trio, violin concert, strings chamber orchestra, solo concert, and operas. These techniques were not unique at the time, but Mozart improved their technical skill and psychological depth. The violin and piano concert was created and made popular almost exclusively through Mozart. In addition to dances, and other types of entertainment, Mozart composed a significant amount of religious music, including big celebrations. All of the essential characteristics of the classical style are present in Mozart's compositions (Gasenzer & Neugebauer, 2017). Mozart's music is known for its clarity, harmony, and transparency, but a narrow understanding of its delicate nature hides from listeners the extraordinary, sometimes demonic intensity of some of Mozart's greatest works, such as the Piano Concert (Daud and Sudirman, 2017).

2.2 Human Brain Cells

The brain is a combination of various cell groups, each of which has special characteristics. Neurons and glia, a type of non-neuronal cell, are the most prevalent types of brain cells. Around 100 billion neurons and an equal number of cells in the brain can be found in the usual adult human brain. Whereas neurons are the most well-known brain cells, neuroglia are also important for normal brain activity (Spaethling & Eberwine, 2017). The brain's neurons are the cells that communicate and receive both biochemical and electromagnetic messages. They serve as the brain's key components and act as message carriers for the body's organs and tissues, reflexes, as well as other neurotransmitters. Individuals are able to touch, breathe, and absorb the world surrounding them. The cell body, or nerve cell, branched neurons that receive signals from fellow neurons, and the axonal, which transmits messages to neighbouring cells through the neuronal terminal, are the three fundamental components of a brain (Jorfi & Irimia, 2018). Whenever a brain releases an action potential, electric and chemical impulses go over a tiny gap known as the synapses from the axons of one neuron to the nerve cells of some other neurons (Tran & Bardy, 2020).

2.3 Importance of Music for human brain cells

Music can help with learning, focus, and memory. Moreover, it can increase overall mental fitness, improve physical productivity, and lower stress. Learning, memory, and cognition can all be improved by music listening. As well as lowering anxiety, blood pressure, as well as discomfort, music listening can also enhance mood, sleep patterns, mental clarity, and memory. People can be energised, uplifted, or calmed and comforted by music (Gasenzer & Neugebauer, 2017). People can experience almost all of the feelings they encounter in their daily lives due to music. Music is a fundamental human phenomenon and generating processes mirror brain processes. Because it can facilitate personal interactions, human meaning, and the human vision of possibilities, music often serves a practical purpose by appealing to our social impulses and promoting human well-

being. Humans have a significant passion for teaching, and music has been connected to learning. Learning happens through both the acquisition of specific musical abilities as well as the associations between musical and emotional aspects. Music has been found to engage some of the brain's most extensive and diverse networks. Listening to music stimulates the brain structures in the temporal divisions next to the ears. When listening to emotional music, the emotional brain regions are not just engaged but also coordinated. Moreover, music stimulates a number of memory areas (Jorfi & Irimia, 2018).

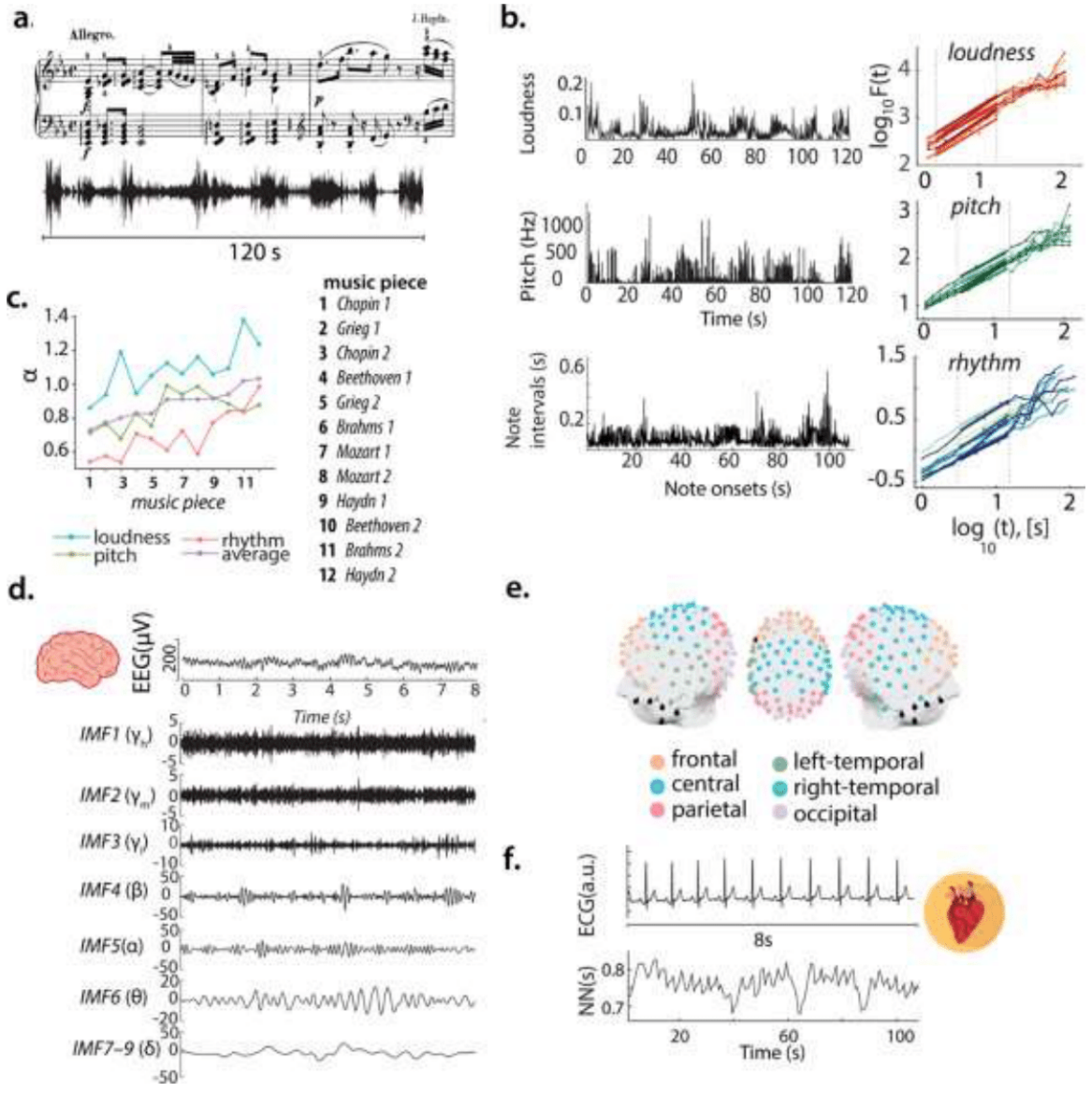

Figure 1: Scaling pattern of impacts of music on brain (Source: Teixeira Borges et al., 2019)

2.4 Effect of Mozart's Music on human brain cells

Music has a strong influence on people. It can enhance brain cells, increase job duration, uplift the mood, decrease stress and depression, fight off tiredness, increase the responses to pain, and support the more efficient exercise. In the brain, music may stimulate neurogenesis, allowing for the growth of new cells and enhancing memories (Ramdinmawii & Mittal, 2017). Moreover, Mozart's music has an impact on how the brain works and how people behave, such as by lowering stress, pain, and depressive symptoms as well as enhancing cognitive and physical skills, spatial-temporal memory, and neurogenesis, the brain's capacity to create new cells (Gasenzer & Neugebauer, 2017).

Furthermore, Xing and Yao (2016) conducted a big study including 20,000 participants revealing that Mozart's music influences mood and the results were incredibly consistent. Many people were asked to listen to classical and Mozart's music composed by different composers during different musical eras, and they were then asked how Mozart's music influenced their emotions. Their findings demonstrated that, based on rhythm, the impacts of moods varied from one individual to another. Non-musical people like both music rarely and with little passion, although semi-musical people really enjoy both music frequently and with high intensity, whereas musical people appreciate Mozart's music infrequently as well as with great passion, due to discriminating preferences. Furthermore, one of Hidayati and Widjiati's (2018) studies indicated that music can have a positive influence on neurotransmitters in the brain including such dopamine, which is associated with emotions of happiness, and oxytocin, the so-called "loving hormone." Moreover, Bedetti and Elisei (2019) in their analysis revealed that listening to Mozart's music helps reduce stress levels. It gives the brain a complete workout. According study conducted by Daud and Sudirman (2017) stated that listening to music can enhance brain, happiness, sleep patterns, and mental clarity while lowering stress, blood pressure, and pains.

2.5 Influence of Mozart's music on human brain cells in different stages of learning, priming and consolidation

The Mozart effect is the connection between music and various learning stages. All behavioural changes brought on by experiences, particularly those involving learning, are widely assumed to be the outcome of alterations in the connections that arise from the simultaneous (or nearly simultaneous) stimulation of the neurons that produce them. Music serves as an exercise for stimulating and priming the general repertory as well as the continuous flow of cortex-discharging patterns that are important for higher brain processes (Tokuhama-Espinosa, 2015). According to Penhune (2020), music is a "prelanguage" that is accessible from an early age and also can access these intrinsic discharge patterns. This enhances the cortex's capacity for pattern generation, which benefits other higher brain processes. The "Mozart effect," which is the alleged improvement in performance or alteration in neurophysiological activities brought on by listening to Mozart's music, served as the foundation for this reasoning.

Consolidation refers to the post-training stage when the anticipated procedure of brain transmission occurred and converts from an unstable state into a more stable one. Priming refers to the facilitative effect of doing one task on the later execution of the same or comparable activities. The majority of investigations looking at the Mozart effect employed a method where the same subjects were exposed to both the control and experimental circumstances. Music may have had an impact on memory and learning in addition to its priming effect because these factors were partially offset. Studies have demonstrated that even when the two stimuli are connected, pre-exposure to auditory activities does not easily stimulate visual actions (Talero-Gutiérrez & Saade-Lemus, 2018). Moreover, a recent fMRI study found that the Mozart concert significantly altered the engagement of the cerebellum, visual cortex, and dorsolateral pre-frontal cortex, all of which are known to be crucial for spatial cognition. According to Terry's (2017) priming theory of the Mozart effect, comparable brain activation underlies the relationship between

listening to music and spatial and temporal thinking. The consistency among observed variations in behavioural measurements and physiological measurements, on the one hand, and the assumptions about how Mozart's music affects Spatio-temporal reasoning, support the contention that the observed trends of EEG action are a result of this influences rather than merely a side effect of music listening in overall (Xing & Yao, 2016).

3.0 Material and Methods

The research philosophy pertains to how the researcher believes a research work should be carried out (Alharahsheh & Pius, 2020). The interpretive philosophy has been used by the researcher for the current analysis. The rationale for employing the interpretative research paradigm was that it made it easier for the researcher to completely answer the objective of the proposed study, which was to explore the impact of Mozart's music on human brain cells and the influence of Mozart's music on human brain cells in different stages of learning, priming and consolidation. Moreover, an inductive strategy was used for this investigation because it simplifies how to address the issue at hand. In addition, the research design is a methodology that involves broad selections and procedures for acquiring and evaluating data (Bloomfield & Fisher, 2019). Furthermore, the qualitative research design was chosen as the research's methodological choice. The rationale for implementing this research design is that it allowed the researcher to explore the impact of Mozart's music on human brain cells and the influence of Mozart's music on human brain cells in different stages of learning, priming and consolidation. A secondary qualitative research strategy was used by the researcher for the proposed investigation.

The researcher has selected the secondary data collection approach for the current investigation. The rationale for selecting the secondary data gathering technique was that it enables materials to be gathered from a wide range of sources in order to meet the present study purpose, which was to explore the impact of Mozart's music on human brain cells,

whereas the primary datasets collecting approach was limited to first-hand resources The researcher was using libraries, journals, articles, and academic reports to gather secondary data on the topic of the study. Furthermore, as per the inclusion and exclusion criteria, the researcher in the current analysis only included those articles that were published after 2016 and excluded those articles that were published before 2016. In the present research, the researcher performed content analysis. However, the rationale for conducting content analysis was that it allows conducting a more thorough examination of pertinent research publications and journals, as well as relevant secondary material. The justification for employing content analysis in this evaluation is that it assists in identifying a number of themes that assist practical implementation and inspection of materials. Furthermore, the researcher made assured that any data gathered from secondary publications was appropriately referenced in order to provide credit to the original scholars who had apparently worked on the past studies. The researcher presents all available evidence in its original, authentic form, keeping the greatest moral and ethical standards, instead of manipulating data to affect the results.

4.0 Results

This section of the study is designed with the aim of providing a critical content analysis of the pre-existing evidence within the research literature. Based on the findings addressed in selected research studies, three major themes were developed which will be discussed further in this section, to provide considerate amount of in-depth analysis of the evidence related to the effects of Mozart's music and its association with the brain cells.

4.1 Mozart's music effects

As observed through the course of analysis, music has been considered as a source of healing and stimulating human emotions. According to the study performed by Exbrayat, & Brun (2019) it was evaluated that the music particularly classical music is found to serve as source of diverting the attention of thoughts from an unpleasant experience and promotes future interventions that can be used by the individual in

managing and improving the surge of unusual thoughts. The study also ensured that the adoption of such much for the psychological therapies can be observed to provide significant evidence based clinical benefits and regarded as an important approach in allied medical interventions. The study performed by Liao, Jiang & Wang (2015) reported effective spatial reasoning skills for almost 10-15 minutes, particularly among the group of participants who were primarily exposed to the Mozart's music effects. Another study conducted by Talero-Gutiérrez & Saade-Lemus (2018) supported the similar findings stating that listening to Sonata for 10 minutes, shows substantial impacts in terms of reducing the rate of stress among the people.

Music serves as an effective source reducing panic attacks, stress and depression among the patients in preoperative and postoperative stages as well. The patients who are provided with Mozart's therapy were observed to express lower blood pressures, pulse rate and anxiety, during the hospital stays (Gasenzer, Kanat & Nakamura, 2021). It can be observed through clinical evidence that music is also used recently in the antenatal clinics as it is one of the effective methods of increasing the heart rate among fetus, promoting good health and cognition. The Mozart effects shows that the rate of aggression and agitation substantially reduces among the adults if provided in an organised manner. Lin & Yang (2015) also observed Analgesic, calming, antiemetic, and sleep-inducing benefits of appropriate music in the palliative care context. Research studies have noted that listening to Mozart's music for 10 minutes improved spatial-temporal thinking abilities. Even in cases when the outcomes were favourable, the improvement was rather slight and lasted for approximately 12 minutes. General intelligence is unaffected; the effect varies between individuals and is dependent on the spatial tasks selected. More remarkably, it has a positive impact on certain epilepsy patients. Although the outcomes are not unique to Mozart's compositions, the precise musical standards necessary have not yet been fully established.

4.2 Impacts of Mozart's music on brain cells

Several studies were performed on animal groups like rats to test the impacts of the Mozart's music on the brain cells. It was initially unlikely that the sound waves generated by the music compositions develops its impacts on the physical systems like the nervous system promoting the feeling of pain, mimics respiratory patterns, blood pressures and the emotions in an individual (Daud & Sudirman, 2017). As observed, neuromusicology is regarded as a term that is used to determine the association of nervous system and the manner of individuals' interaction with the music in a rhythmic manner. According to the study performed by Coppola et al. (2015) it can be reported that the sound waves generated through different composition of music proceed through a marked pathway within the body, initially entering cochlea. The cochlea is responsible to extract and sort sound waves and convert them into the elementary frequencies. These elementary frequencies are then transmitted as neural discharges to the auditory cortex present in the temporal lobe of brain, using the medium of tuned fibres of auditory nerves. Similar findings were observed in the study performed by Talero-Gutiérrez & Saade-Lemus (2018) who added that the temporal lobe of brain consists of specialized cells that are primarily responsible to respond appropriately to certain frequencies. In here, there occurs an overlapping of the tuning curves through the neighboring cells which helps in preventing the gaps within the system. The brain cells group together the sequences of different tones of music instead of interpreting them directly, to identify the relationship between different sound waves. Identifying complexity is much more challenging than recognising a large number of isolated stimuli, like as musical tones, but requires organising the stimuli into patterns and comprehending how the patterns connect to each other.

The study performed by Ramdinmawii & Mittal (2017) addressed that human brains are capable to perform better while performing learning and memory examination after them listening to 10 minutes of Sonata. In support to the evidence Xing & Yao (2016) reported that after listening to sonata in comparison to control rats that had

listened to the same amount of white noise, smarter rats showed enhanced gene expression of BDNF (a brain growth factor), a synaptic growth protein (synapsin I), and CREB (learning and memory complex), within their hippocampus.

4.3 Impacts of Mozart's music on learning, priming and consolidation

Ramdinmawii & Mittal (2017) reported in the study that Mozart's music contributes a significant role in promotion of the learning behaviours towards the foreign languages, mathematics, terminology retention and reading rapidly. The effects of certain musical compositions on arousal and a favourable mood on human conduct was typically explained in the findings of the study. It was analysed that listening to Mozart's music develops a direct and significant impacts on the degree of physiological activations, promotes positive emotional surge and enable long term emotions. All of these effects helps in accelerating the performance of an individual in variety of tasks, requiring cognitive and intellectual efficiencies. Talero-Gutiérrez & Saade-Lemus (2018) seconded that according to the Trion model of cortical structure, similarities in brain activation support the relationship between spatio-temporal reasoning and listening to music. This study efficiently reported that the shared repertory and sequential flow of the cortical firing patterns that are accountable for increased rate of brain activities are primed and stimulated by listening to Mozart's music.

On the other hand, the study conducted by Terry's (2017) reported that Mozart's music is considered as a pre-language which should be available at the early stages of learning for the purpose of enhancing the ability of cortex and inherent synapse firing patterns to promote brain development and sustainable physiological functioning. This justification was predicated on the aspects of "Mozart effect," which refers to an improvement in performance or alteration in neurophysiological activity brought on by listening to Mozart's music. The study also observed a substantial increase in the spatial IQ levels, but it was not persistent beyond the duration of 10-20 minutes among the participants. In a recent analysis by Jorfi & Irimia (2018) it was evaluated that the

background stimulation of the auditory nerves through music also influence the visual activity of the brain cells. This was tested on students and determines that they were potentially able to solve the simple task more rapidly after listening to the Mozart's sonata. The effects were observable mainly in the *y* band. While a decoupling in brain regions associated with *y* band was observed among students who were not exposed to the Mozart's music before the performance of simpler tasks.

These findings are also supported by Ramdinmawii & Mittal (2017) stating that the oscillations that subsequently occurs in the *y* bands plays a viable role in music developing music perceptions. According to this study, the listening of Mozart's music develops beneficial impacts on the performances of spatial rotation tasks. While a contradicting analysis showed that a slightly negative impact of Mozart's music on numerical tasks as it served to deviate the level on concentration and cognitive attention. Various fMRI and PET studies have been observed to clinically support the Rauscher's priming theory. Among these a study performed by Jorfi & Irimia (2018) reported that Mozart's music promotes the overlapping of regions associated with the generation of perception-action cycle. Moreover, areas associated with perception making, memory, production of syntax, abstract sequences and language understanding are highly influenced by Mozart's sonata. All behavioural changes brought on by experiences, particularly those involving learning, are usually believed to be the outcome of alterations in the synapses that arise from the simultaneous firing of the neurons that produce them. According to research, memory is a time-dependent process that can be altered at various phases or stages of learning, priming and consolidation.

5.0 Discussion

This research study was designed for the purpose of analysing the potential impacts of music on brain cell, considering the case of Mozart's music. The findings of the study were comprehensive in a manner of addressing various impacts of music and the association of brain cells with the sound waves generated by different music compositions.

The findings suggested that the conditions in which Mozart's music is considered before performing different learning activities and performing tasks showed significant beneficial impacts on the cognitive performances. Particularly, Mozart's music promotes the effective performance of spatio-temporal rotation tasks. The shreds of evidence obtained from literature also ensured that listening to Mozart's music have a measurable impacts on the EEG activities (Xing & Yao, 2016). According to Jorfi & Irimia (2018) listening to rap or hip hop music promotes negative brain cell activity and disturbances in the overlapping of *y* bands. Mozart's music has the ability to strengthen brain cells, lengthen the time spent working, improve mood, lessen anxiety and depression, resist against fatigue, boost pain tolerance, and encourage more effective exercise.

Music may encourage neurogenesis, which promotes the development of new brain cells and improves memory, in the brain. Through findings of this study, it was hypothesised that the inhibition of competing and irrelevant activity was responsible for the observed reduction in the complexity of brain dynamics in high intelligence individuals. Conversely, when doing the identical task, less intelligent people have more diffuse neuronal dynamics (Ramdinmawii & Mittal, 2017). The course of analysis supported the notion that listening to Mozart's music has a large and direct impact on the level of physiological activations, encourages a pleasant emotional outburst, and facilitates long-lasting emotions. All of these impacts contribute to improving a person's performance on a range of tasks that call for mental and cognitive agility. Dopamine, a neurotransmitter linked to feelings of euphoria, and oxytocin, the so-called "love hormone," can both be positively influenced by music. Through these evaluations it can therefore be reported that the Mozart's music has the ability to evoke the substantial differentiation in the neural activities with the term of promoting the spatio-temporal reasoning (Talero-Gutiérrez & Saade-Lemus, 2018). These assumptions are further supported in various studies addressing that musician associated to classical and sonata tones expresses effective phase of coherence which is regarded as inversely related to dimensional complexity. In

comparison to non-musicians, musicians exhibit higher degrees of y band synchrony while listening to music and while using their spatial imagination. Therefore, the evidence points to the activation of particular task-relevant brain areas as well as the suppression of task-irrelevant brain areas brought on by listening to Mozart's sonata as the cause of the improved performance in spatio-temporal thinking (Daud & Sudirman, 2017).

The oscillations that follow in the y bands contribute significantly to how people perceive music. This study found that listening to Mozart had a positive effect on how well spatial rotation tasks are performed. Mozart's music had a mixed effect on numerical activities, according to a contrary investigation, as it served to divert cognitive attention and concentration levels (Gasenzer & Neugebauer, 2017). It is generally accepted that all behavioural changes brought on by experiences, notably those that involve learning, are the result of changes in the synapses that develop from the simultaneous firing of the neurons that create them. According to research, memory is a temporally variable process that can be changed at different learning, priming, and consolidation stages. This positive effect was physiologically accompanied by a decrease in complex brain activity, attentiveness, and semantic memory processing (Daud & Sudirman, 2017). It has been discovered that listening to music, especially classical music, might help to shift thoughts away from bad experiences and encourage potential future interventions that a person can utilise to better control and manage their atypical thought influx (Gasenzer & Neugebauer, 2017). The study also made sure that the use of so many psychological therapies can be seen to have considerable clinical benefits supported by data and be recognised as a key strategy in auxiliary medical intervention.

6.0 Conclusion

According to neurobiological studies, listening to one's favourite music can cause feelings of elevated arousal, which temporarily leads to improved performance across a wide range of cognitive areas. This beneficial outcome was not just limited to Mozart's sonata. Several researches have noted that listening to Mozart for 10 minutes

improved spatial-temporal thinking abilities. Even in cases when the outcomes were favourable, the improvement was rather slight and lasted for approximately 12 minutes. General intelligence is unaffected; the effect varies between individuals and is dependent on the spatial tasks selected. More significantly, the brain's rhythmic rhythms and cells are positively impacted. Although the outcomes are not unique to Mozart's compositions, the precise musical standards necessary have not yet been fully established.

6.1 Recommendations

Several healthcare settings are successfully utilising the arousal phenomena. However, methodological shortcomings restrict the scientific rigour of many clinical investigations in this field. This strongly suggests the necessity for well-designed prospective randomised studies to determine the efficacy under clinical conditions, preferably in a blinded method. However, current information reveals that there is moderate but not entirely convincing evidence that listening to well-known and liked music, a typical aspect in music therapy, leads to a reduced disease burden and greater well-being as well as less stress in patients. Since many of the investigations only include brief amounts of time listening to Mozart's piano sonata K448 in their experiments, it is still unclear how practical applications of such discoveries might be used. Before the effect can be completely evaluated, more research that involves longer-term exposure to Mozart and a wide range of other composers is required.

References

Alharahsheh, H. H., & Pius, A. (2020). A review of key paradigms: Positivism VS interpretivism. Global Academic Journal of Humanities and Social Sciences, 2(3), 39-43.

Bedetti, C., Principi, M., Di Renzo, A., Muti, M., Frondizi, D., Piccirilli, M., ... & Elisei, S. (2019). The effect of Mozart's music in severe epilepsy: functional and morphological features. Psychiatria Danubina, 31(suppl 3), 467-474.

Bloomfield, J., & Fisher, M. J. (2019). Quantitative research design. Journal of the Australasian Rehabilitation Nurses Association, 22(2), 27-30.

Coppola, G., Toro, A., Operto, F. F., Ferrarioli, G., Pisano, S., Viggiano, A., & Verrotti, A. (2015). Mozart's music in children with drug-refractory epileptic encephalopathies. *Epilepsy & Behavior*, *50*, 18-22.

Daud, S. N., & Sudirman, R. (2017). Evaluating the effect of Mozart's music and white noise on electroencephalography patterns toward visual memory. Advances in Science, Technology and Engineering Systems Journal, 2(3), 1372-1380.

Exbrayat, J. M., & Brun, C. (2019). Some effects of sound and music on organisms and cells: a review. *Annual Research & Review in Biology*, 1-12.

Exbrayat, J. M., & Brun, C. (2019). Some effects of sound and music on organisms and cells: a review. *Annual Research & Review in Biology*, 1-12.

Gasenzer, E. R., Kanat, A., & Nakamura, M. (2021). The influence of music on neurosurgical cases: a neglected knowledge. *Journal of Neurological Surgery Part A: Central European Neurosurgery*, *82*(06), 544-551.

Gasenzer, E. R., Kanat, A., & Neugebauer, E. (2017). Neurosurgery and music; effect of Wolfgang Amadeus Mozart. *World neurosurgery*, *102*, 313-319.

Grylls, E., Kinsky, M., Baggott, A., Wabnitz, C., & McLellan, A. (2018). Study of the Mozart effect in children with epileptic electroencephalograms. *Seizure*, *59*, 77-81.

Hidayati, A., Joewono, H. T., & Widjiati, W. (2018). Increased Brain-Derived Neurothropic Factor in the cerebrum and cerebellum of Rattus norvegicus newborn with exposure to Mozart's music in default sequence compared with the reversed sequence and without exposure during gestation. Majalah Obstetri dan Ginekologi, 26(2), 67-73.

Jorfi, M., D'Avanzo, C., Kim, D. Y., & Irimia, D. (2018). Three-dimensional models of the human brain development and diseases. Advanced healthcare materials, 7(1), 1700723.

Liao, H., Jiang, G., & Wang, X. (2015). Music therapy as a non-pharmacological treatment for epilepsy. *Expert review of neurotherapeutics*, *15*(9), 993-1003.

Lin, L. C., & Yang, R. C. (2015). Mozart's music in children with epilepsy. *Translational pediatrics*, *4*(4), 323.

Penhune, V. B. (2020). A gene-maturation-environment model for understanding sensitive period effects in musical training. *Current Opinion in Behavioral Sciences*, *36*, 13-22.

Ramdinmawii, E., & Mittal, V. K. (2017, August). The effect of music on the human mind: A study using brainwaves and binaural beats. In 2017 2nd International Conference on Telecommunication and Networks (TEL-NET) (pp. 1-7). IEEE.

Ramdinmawii, E., & Mittal, V. K. (2017, August). The effect of music on the human mind: A study using brainwaves and binaural beats. In *2017 2nd International Conference on Telecommunication and Networks (TEL-NET)* (pp. 1-7). IEEE.

Ramdinmawii, E., & Mittal, V. K. (2017, August). The effect of music on the human mind: A study using brainwaves and binaural beats. In *2017 2nd International Conference on Telecommunication and Networks (TEL-NET)* (pp. 1-7). IEEE.

Spaethling, J. M., Na, Y. J., Lee, J., Ulyanova, A. V., Baltuch, G. H., Bell, T. J., ... & Eberwine, J. H. (2017). Primary cell culture of live neurosurgically resected aged adult human brain cells and single cell transcriptomics. Cell reports, 18(3), 791-803.

Talero-Gutiérrez, C., & Saade-Lemus, S. (2018). Demystifying the Mozart effect: Facts beyond the controversy. *Psychobiological, clinical, and educational aspects of giftedness*, 67-85.

Teixeira Borges, A. F., Irrmischer, M., Brockmeier, T., Smit, D. J., Mansvelder, H. D., & Linkenkaer-Hansen, K. (2019). Scaling behaviour in music and cortical dynamics interplay to mediate music listening pleasure. *Scientific reports*, *9*(1), 1-15.

Terry, W. S. (2017). *Learning and memory: Basic principles, processes, and procedures*. Routledge.

Tokuhama-Espinosa, T. (2015). *The new science of teaching and learning: Using the best of mind, brain, and education science in the classroom*. Teachers College Press.

Tran, J., Anastacio, H., & Bardy, C. (2020). Genetic predispositions of Parkinson's disease revealed in patient-derived brain cells. NPJ Parkinson's disease, 6(1), 1-18.

Xing, Y., Xia, Y., Kendrick, K., Liu, X., Wang, M., Wu, D., ... & Yao, D. (2016). Mozart, Mozart rhythm and retrograde Mozart effects: pieces of evidence from behaviours and neurobiology bases. *Scientific Reports*, *6*(1), 1-11.

Xing, Y., Xia, Y., Kendrick, K., Liu, X., Wang, M., Wu, D., ... & Yao, D. (2016). Mozart, Mozart rhythm and retrograde Mozart effects: pieces of evidence from behaviours and neurobiology bases. Scientific Reports, 6(1