Evaluate the Importance of Music Education for Young Children for Brain Development

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Abstract: This research endeavors to meticulously evaluate the pivotal role played by music education in shaping the neural architecture of young children and, consequently, its implications for overall brain development. Exploring advanced neuroimaging machineries such as functional magnetic resonance imaging (fMRI) and electroencephalography (EEG), the study aims to pinpoint specific neural pathways and regions activated during musical engagement. The methodology of this study integrates both quantitative and qualitative approaches, drawing on a diverse range of literature from fields such as neuroscience, psychology, and musical education. It was seen in the results that music education program during early childhood significantly contributes to the enhancement of cognitive functions. Implications of this research extend to educational policy and practice. By providing empirical evidence supporting the significance of music education, it advocates for the integration of comprehensive music programs in early childhood curricula.
Keywords: Music Education, Brain Development, Cognitive Enhancement, Early Childhood.

1. INTRODUCTION

1.1 Background and Context

In the landscape of early childhood education, the effect of music education on the cognitive progress of young minds stands as a topic of increasing significance. For the betterment of the child's brain, it is imperative to notice that the procedure of development of the brain starts early on, from the fetus to be precise. This development takes place throughout childhood until the age of 12. For a child's brain to grow, the first three years of life are critical which lays the groundwork for subconscious as well as conscious development. The brain of a child, at this point, is sensitive to the surroundings, learning and observing each and everything they are subjected to. Inadequate brain development can take place in children if they are subjected to low levels of stimulation, stress and insecurity (Halliburton & Watson, 2008). The primary objective is to scrutinize the multifaceted impact of music education programs on cognitive functions critical to early childhood development. One focal point of this research is the exploration of the neurobiological mechanisms

that underlie the positive effects of music education. Neuroscientists have revealed that the impact of musical training occurs significantly on the brain's shape and function (Mehr et al., 2013). Through neuroimaging practices such as electroencephalography (EEG) and functional magnetic resonance imaging (fMRI), studies have demonstrated how engaging with music can lead to notable changes in the brain's architecture, particularly in regions responsible for auditory processing, memory consolidation, and executive functions (Zatorre et al., 2007). Understanding the neurophysiological foundations of how music influences cognitive processes will not only deepen our comprehension of the subject but also contribute valuable insights for designing effective educational interventions. Music education plays an important role in laying the foundation of children's cognitive development. Cognitive development begins from infancy and only progresses towards betterment when exposed to musical stimuli. It is reported to have pivotal effects on attention control working memory, spatial-temporal information and refined auditory discrimination skills (Southgate & Roscigno, 2009). Schellenberg stated that musical education serves as a catalyst for the enhancement of various cognitive abilities (Schellenberg, 2004).

1.2 Research Questions

The current study's aim is described below: 1. To explore the Piagetian theory of Cognition in children and its relevance for music education 2. To inspect the impact of music on cognitive neurological progress.

2. LITERATURE REVIEW

There is an inevitable connection between the fields of neuroscience and music which is proved by many neuroscientists. Zatorre mentions in his study the mix of human cognitive functions and music and provides valuable insights into the development of the brain regarding the connection between the two (Zatorre et al., 2007). In the study presented by Collins, the connection between music education and neuroscience is explored and how it positively affects the development of the brain in children (Collins, 2014). The review of this meta-analysis revealed that significantly optimistic changes were observed in the brain structure who received musical training on a weekly basis for more than two years. Early training is also viewed as optimistic in this meta-analysis which showed significantly vital changes in the brain structure of those who start learning

any musical instrument early in their life. Early exposure to music education would lead to greater benefits in the neurological development of a child's brain. It was concluded in this study that the type of music, age range and practice period also matter for music education in children which would create differences in statistical and neurological results. Furthermore, a fairly common term known as "The Mozart Effect" has been researched by Jenkins which explores the phenomenon of the theory surrounding Mozart's music and its ability to boost cognitive functions (Jenkins, 2001). The influence of hearing on Mozart's composition on intellectual abilities is discussed at length in the research conducted by Rauscher et al. (Rauscher et al., 1997). The results revealed that spatial-temporal reasoning is found to be enhanced right after being exposed to Mozart's music for approximately ten minutes. It is also elaborated that the scientific community remains divided since even in the positive results, the enhancement is only observed in a small amount and lasts for about twelve minutes. Moreover, the initial positive findings have been questioned for their generality, arguing that any Mozart effect is the result of "enjoyment arousal" instigated by this exact music and would not happen in the absence of its appreciation. In another study conducted by Rauscher et al., the long-term consequences of music on a child's brain were revealed which were studied in pre-school kids of 3 or 4 years of age (Rauscher et al., 1997). These kids were subjected to musical lessons on the keyboard for six months. During this time period, they learned all sorts of musical techniques which included the learning of musical notations, pitch intervals, sight reading and many more. When training ended, the children had a grip on the performance of Mozart and Beethoven, but on a simpler level. After this, their spatial-temporal reasoning was texted according to their age which exhibited 30% betterment when compared to the children who were subjected to computer lessons. Further experiments (Graziano et al., 1999) showed that piano lessons showed enhancement of spatial-temporal reasoning in kids, resulting in mathematics higher scores. The research concluded on the note that the musical criteria in which enhancement is shown has not been specified and more extensive research is required in this field. Moreover, the discussion of the impact of music on a baby's brain development is discussed at length in another research (Fox, 2000). It is emphasized by the author about the impact of music on an infant's brain development which helps in their cognitive and emotional development. Past research has shown the understanding that the initial years of a child are crucial for their brain development and early education plays an important role in this part. Previous research suggests that before

a baby's birth, brain development takes place and is affected by the fetus's own motor and sensory experiences. There is no single rationale or concrete evidence to support this claim, but previous research suggests that the bond between a mother and her child is supported by the musical experience they may have had before the child's birth. Future research is suggested on this topic with the help of funding to further the cause of music education from a very early age of children.

3. METHODOLOGY

3.1 Research Design

This secondary mixed-method research integrates both qualitative as well as quantitative analysis which discusses a range of literature from the field of psychology and music along with its influence and application in the education system. The qualitative analysis includes the exploration of a cognitive theory and the impact of early musical education on children. The quantitative examination involves the investigation of the impact of music on the human brain.

3.2 Data Collection and Analysis

The data collected for this research was obtained from Google Scholar and Pub Med. In-depth analysis was conducted by closely reading the material collected from the sources mentioned above. The data of this research ranges from neuroscience and psychology to musical education in children's brain development. The cognitive influence of music on the brain's development is also discussed.

3.3 Ethical Considerations

The ethical considerations were kept under proper check-and-balance. Proper citations and references are present.

4. FINDINGS

4.1 Piaget's Theory of Cognition

Jean Piaget, a Swiss psychologist, proposes that there is a certain process of intelligence that children go through, starting from their early life. A child's development of cognition is more than just acquiring knowledge. They are also required to create a mental surrounding where abstract thinking takes place (Miller, 2011). It is believed by Jean Piaget that children

possess the ability to view the world differently when compared to adults and that the best way to comprehend why and how a child reaches a particular reason is by thinking from their perspective. The premise of the Theory of Cognitive Development is that children develop themselves in four distinct phases, each with its own special traits and skills. His interest in the cognitive development of children peaked because of his daughter and nephew. He divided the development into four distinct stages of cognitive development which ranged in age as well. A study conducted by Zimmerman argued that the Piagetian theory of cognitive development has relevance to music education and practices (Zimmerman, 1984). The four stages of Piaget's theory and its relevance to music education are defined below:

4.2 Sensorimotor Stage (Birth to 2 years)

This stage is the earliest phase of cognitive development where infants acquire knowledge through their surroundings by experiencing the usage of their senses. They manipulate objects and explore their senses in this early stage of development, basing their childhood experience on fundamental reflexes, motor responses and distinct thoughts and beliefs. At this age, they learn about basic movements and sensations with the realization that their actions have consequences. Discoveries are made during this time as they interact with their atmosphere. The significant phenomenon of object permanence is also learned by children during this time, which states that an object exists even when it is hidden from view. Exposing children to music, during this time of growth, would lead to the maintenance of a stimulus in the child's brain, making them relate one musical note to another (creating a sequence of musical sense). Furthermore, in order to engage the dispersed network of regions of the brain, exposing children to music enhances their auditory memory, tone distinction, and focused attention. Through this distinction, children can start associating and attaching words to objects and concepts.

4.3 Preoperational Stage (2 to 7 years)

During this age, children develop their language on a much clearer level, associating words with objects of which the foundation was laid in the previous stage. Children begin to associate words with pictures and start to think about symbols. The tendency of egoism is exhibited during this age when they think that they are correct, failing to understand others' perspectives. They become relatively better with terminologies but tend to think in very simple and concrete terms. They also find it difficult to

differentiate between reality and imagination, for instance, the monster they believe is under their bed. Children during this time have a tough time with logic and reasoning. Exposing children to music during this age can result in higher IQ. Research suggests that learning an instrument as a child increases academic performance as well as other skills (Miendlarzewska & Trost, 2014). Children who are subjected to musical training are found to have a better grip on the pronunciation of the second language, better verbal memory, and reading ability. All of this, along with their cognitive abilities, depends upon the time duration of their practice and intensity.

4.4 Concrete Operational Stage (7 to 11 years)

During this time, Piaget describes that logic prevails and ego starts to fade away. Empathy is developed as they start to put themselves in other people's shoes. Thoughts become much more reasonable during the concrete operational stage; they might also become quite rigid. At this developmental period, children usually struggle to grasp concepts that are hypothetical or abstract.Teaching the children music during his time can be extremely helpful as they start associating meaning with the music, building an emotional connection and enhancing brain activity. Previous studies have shown an increase in brain plasticity due to exposure to music (Zhang, 2020).

4.5 Formal Operational Stage (12 years and up)

This is the final phase of Piaget's cognitive development theory. In this phase, the comprehension of abstract ideas and deductive reasoning is observed. Adolescents develop the capability to view a problem from multiple perspectives to figure out solutions. The introduction of moral and ethical philosophy is done where they develop an ideology to support their reasoning. The key takeaway from this final phase is the ability to develop critical thinking and abstract thinking. Additionally, their ability to plan for their future and use deductive logic and reasoning are also considered significant skills which every young adult should be equipped with. The brain of a child who is trained in music is considered to have an advanced speed. Children who are trained in musical instruments can read musical notes in their brains and associate notes with the physical motion of the instrument, having better hand-eye coordination.

4.6 Influence of music on cognitive neurological development

The impact of music on the cognitive neurological development of the brain has been in discussion for over a decade among neuroscientists.

Through the scans of fMRI and EEG, the incorporation of music has exhibited increased brain plasticity and enhancement in the cognitive neuroscience of the brain (Zhang, 2020). The art of sound, or music, uses sound to create an artistic image. It might include combining several aspects like pitch, tone, rhythm, harmony, and melody to create a whole composition for performance, or it can involve listening to and feeling these elements individually. An individual brain's auditory cortex is involved in sophisticated cognitive processes including analyzing sounds, auditory recall, and auditory scene interpretation because it plays a crucial role in monitoring and detecting (Seibert et al., 2000). The auditory cortex activity is seen the largest in those who have learned instrumental music before the age of 9 (Koelsch, 2009). The article presented by Mahmood et al., covers the effect of music on the functional connectivity of the brain as well in which applicants were subjected to their favourite music which is also relaxing with alpha binaural beats (Mahmood et al., 2022). This experimental research was conducted in two parts, short and long duration. The subjects were subjected to their favourite music while the EEG machine recorded the signals. The functional connectivity of the brain is affected by the sorts of music that are listened to. The listener's functional connection varies based on the kind and genre of music. The results of the short study displayed that hearing their favourite or relaxing music introduced relaxation but the relaxation was much more significant in the participants when subjected to relaxing music only. Through t-test and ANOVA, the significance of this study was displayed. By comparing the long and short studies, the effects of listening to relaxing music were seen as more significant.

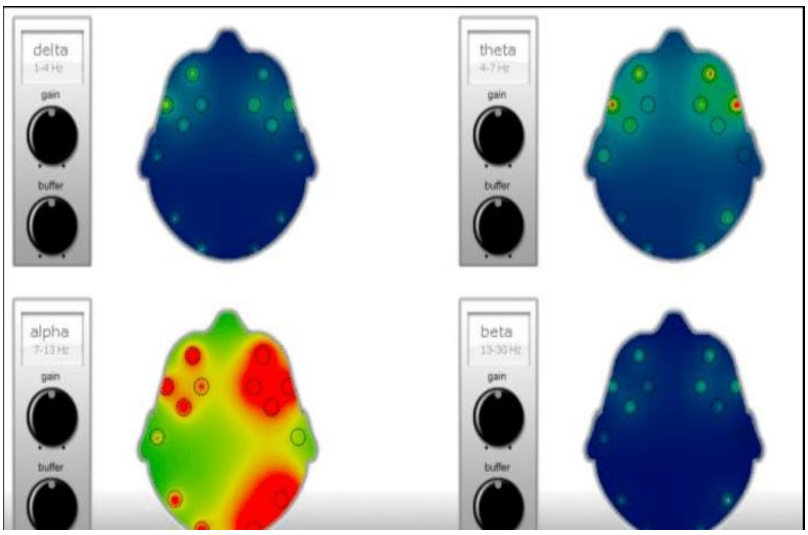

Figure 1: Increased brain activity through EEG while listening to relaxing music (Koudelková & Strmiska, 2018)

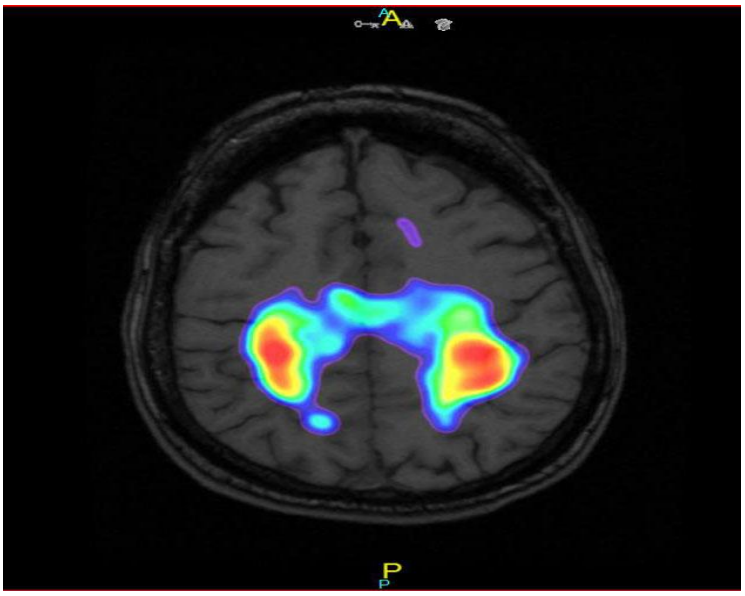

Figure 2: fMRI of brain's activity to music

5. DISCUSSION

The results of this research explore the Piagetian theory of cognition in children with relevance to music education and listening to music. This theory suggests that the cognitive development of children's brains can be enhanced through exposure to musical education and training. The four stages of cognitive development discussed in the sections above suggest the positive influence of music on the development of children's cognition. Moreover, the investigation of music's influence on cognitive neurological development is also present which suggests a positive correlation between brain development and music learning and education. Previous literature also suggested the connection between human cognitive functions and music education.

6. CONCLUSION AND SUGGESTIONS

This mixed-method research analyses the integration of music education from an early age and the role it plays in the cognitive progress of a child's brain. The extensive literature review focuses on the connection between musical exposure and its integral role in neuroscience. Furthermore, the phenomenon of the Mozart Effect is also discussed at length which supports the claim that Mozart's music has the ability to boost cognitive functions. The review of literature also included the influence of music on a baby's brain development and how the brain's progression starts even

before birth. The theory of cognitive development presented by Jean Piaget is discussed in the results section which correlates with the subject of music and its positive influence on cognitive capabilities. Moreover, the positive changes in brain activity through an EEG reading are also discussed. This study can inform educators, policymakers, and parents about the potential long-term advantages of incorporating music into the formative years of a child's education. Beyond the immediate cognitive benefits, such programs may also influence broader aspects of a child's development, including social skills, creativity, and emotional well-being.

7. LIMITATIONS

The limitations of this study include the limited number of research present in this field. More extensive and experimental research is required in this field which would support the claims. Moreover, a limited amount of time was given to carry out this research.

References

Collins, A. (2014). Music education and the brain: What does it take to make a change? *Update: Applications of Research in Music Education*, *32*(2), 4-10.

Fox, D. B. (2000). Music and the baby's brain early experiences: Do young children benefit from early childhood music instruction? Here is a research-based answer. *Music educators journal*, *87*(2), 23-50.

Graziano, A. B., Peterson, M., & Shaw, G. L. (1999). Enhanced learning of proportional math through music training and spatial-temporal training. *Neurological research*, *21*(2), 139-152.

Halliburton, A. L., & Watson, A. L. (2008). Early Childhood Brain Development. *University of Missouri--Columbia. Center for Family Policy and Research*.

Jenkins, J. S. (2001). The mozart effect. *Journal of the royal society of medicine*, *94*(4), 170-172. https://doi.org/10.1177/014107680109400404

Koelsch, S. (2009). A neuroscientific perspective on music therapy. *Annals of the New York Academy of Sciences*, *1169*(1), 374-384. https://doi.org/10.1111/j.1749-6632.2009.04592.x

Koudelková, Z., & Strmiska, M. (2018). Introduction to the identification of brain waves based on their frequency. MATEC Web of Conferences,

Mahmood, D., Nisar, H., Yap, V. V., & Tsai, C.-Y. (2022). The effect of music listening on EEG functional connectivity of brain: a short-duration and long-duration study. *Mathematics*, *10*(3), 349. https://doi.org/10.3390/math10030349

Mehr, S. A., Schachner, A., Katz, R. C., & Spelke, E. S. (2013). Two randomized trials provide no consistent evidence for nonmusical cognitive benefits of brief preschool music enrichment. *PloS one*, *8*(12), e82007.

Miendlarzewska, E. A., & Trost, W. J. (2014). How musical training affects cognitive development: rhythm, reward and other modulating variables. *Frontiers in*

neuroscience, *7*, 63292. https://doi.org/10.3389/fnins.2013.00279

Miller, P. H. (2011). Piaget's theory: Past, present, and future. https://doi.org/10.1002/9781444325485.ch25

Rauscher, F., Shaw, G., Levine, L., Wright, E., Dennis, W., & Newcomb, R. (1997). Music training causes long-term enhancement of preschool children's spatial–temporal reasoning. *Neurological research*, *19*(1), 2-8.

Schellenberg, E. G. (2004). Music lessons enhance IQ. *Psychological science*, *15*(8), 511-514.

Seibert, P. S., Fee, L., Basom, J., & Zimmerman, C. (2000). Case study Music and the brain: the impact of music on an oboist's fight for recovery. *Brain injury*, *14*(3), 295-302. https://doi.org/10.1080/026990500120763

Southgate, D. E., & Roscigno, V. J. (2009). The impact of music on childhood and adolescent achievement. *Social science quarterly*, *90*(1), 4-21.

Zatorre, R. J., Chen, J. L., & Penhune, V. B. (2007). When the brain plays music: auditory–motor interactions in music perception and production. *Nature reviews neuroscience*, *8*(7), 547-558.

Zhang, S. (2020). The positive influence of music on the human brain. *Journal of Behavioral and Brain Science*, *10*(01), 95. https://doi.org/10.4236/jbbs.2020.101005

Zimmerman, M. P. (1984). The relevance of Piagetian theory for music education. *International Journal of Music Education*(1), 31-34.