IJASRM
International Journal of Advanced Scientific Research and Management, Vol.3 Issue 2, Feb 2018
www.ijasrm.com
ISSN 2455-6378

A Review of the Effects of Early Exposure to Music on Brain Development

M.A. Rajalakshmi

PhD Research Scholar, Department of Psychology, Faculty of Science,
Shri JJT University, Jhunjhunu, Rajasthan 333001, India
Consultant Homeopathic Physician and Psychotherapist,
Bangalore, Karnataka, India

Abstract

Music has been a part of everyday life in across cultures and in different parts of the world and more so in India. Music in any form has been considered to be soothing and therapeutic. Recent research studies have helped to corroborate this fact. A literature review of research studies on the effects of music exposure in the prenatal period and the effects on musical training on brain development was conducted. The analysis of these research studies leads to the conclusion that music can indeed have a positive role to play in enhancing brain development.

Keywords: *Music, Brain Development*

1. Introduction

The concept of using music especially Indian classical music has been there from ancient times. In India there has been a practice of getting pregnant mothers to listen to classical music during the last trimester which coincides with the fact that the fetal ear starts to develop at 28 weeks of gestational age (around the 7th month of pregnancy). A review of research studies was undertaken to see if it helps corroborate the ancient beliefs in the therapeutic benefits of music both as a background music intervention and as an active teaching modality.

2. Review of Literature on Music and Brain Development

2.1 Fetal Responses to Music, Kisilevsky BS et al (2004)

In this report, the researchers studied the fetal response to music in the last trimester of pregnancy. According to the researchers it is commonly believed by pregnant women across all cultures that the foetus starts to hear at 25 weeks of gestational age. It is also believed that the foetus responds to music at 26 weeks GA. Although some of these facts are anecdotal, there are research studies that have found that the foetus starts to hear at or near the last trimester of pregnancy. Some research studies have also found that the foetus is able to distinguish music that is played outside while inside the womb. Research studies have also shown that fetuses respond with an accelerated heart rate and body movements at 30 weeks of GA to loud sounds.

The researchers also reviewed a number of studies that examined fetal responses to music. There were different methods used to test fetal response to music such as playing music via headphones placed on the mother's abdomen or through playing the mother's favorite music by placing speakers at the foot of the mother's bed for a few minutes at a time. The fetal response was recorded based on the fetal heart rate and fetal body movements. In many of these studies the fetal response was found to be inconsistent with the heart rate increasing in some fetuses or decreasing in some other. It was thought that the fetal response could have been due to the mother's emotional response and not a direct response to the music.

In this study, the development of auditory perception during the third trimester of pregnancy was analyzed using a musical stimulus. The research study was carried out at two locations Canada and Paris. In Canada, the participants were forty-seven fetuses that had a gestational age of 28 to 38 weeks who were selected from antenatal clinics at a teaching hospital in Ontario. In Paris, the participants were seventy-five at term fetuses with a gestational age of 38 to 41 weeks. A five-minute piano recording of Brahms lullaby at different decibel levels 95 dB,100dB and

110 dB was played to each fetus. There was a five-minute control period with no sounds before and after the music stimulus.

The results of this study showed that the fetuses at different gestational ages (GA) showed changes in heart rate when the music was played. Within 30 seconds of the music being played, the youngest fetuses (28-32 weeks GA) showed a heart rate increase when the lullaby was played at the higher decibels. As the gestational age increased it was seen that threshold level decreased and a shift from increase of heart rate to decrease of heart rate was observed when the lullaby was played at the lower decibel indicating response to the stimulus. Fetuses older than thirty-three weeks of gestational age showed sustained increase in heart rate and at thirty-five weeks of gestational age body movement was observed. This suggests a change in processing of complex sound at thirty-three weeks GA

2.2 Effect of Maternal Music Exposure during Pregnancy, Arya R. et al (2012)

In this randomized clinical trial, the effect of music exposure during pregnancy to first time mothers on the behavior of newborns born at full term was studied. The researchers state that nervous system of the fetus in the womb is exposed to a number of different influences from the external environment. Research studies usually look at the consequences of adverse influences that may lead to structural and functional abnormalities postnatally.

According to the researchers since research studies have shown that negative environmental inputs could have adverse effects, it could be possible that positive inputs could have a beneficial effect in enhancing neural development in the fetus. It has been shown that stimulation of the fetus with music can alter the behavior of the fetus in a positive way. These benefits are also carried forward after birth in the newborn as well. Studies have shown that animals exposed to music in the prenatal period showed improvements in spatial learning and memory postnatally.

This study was conducted at a single centre as an open-label randomized control trial in a teaching hospital from January 2003 to December 2005. The participants for the study were first time pregnant mothers aged 19 to 29 years with a gestation stage below 20 weeks. 339 first time pregnant mothers who attended the antenatal clinics of the teaching hospital were randomly selected for the study. They were assigned randomly to either the music exposure with standard care group (n=169) and the standard care group with no music exposure (n=170).

The mothers in the music group were given a prerecorded music cassette called "Garbh Sanskar" consisting of fifty minutes of mix of instrumental music, chants from religious scriptures and natural sounds, along with a cassette player with headphones. The mothers in the music group were instructed to listen to the music cassette every day in the evening before going to bed. A record of their music listening activity was asked to maintained by putting a check mark on a printed calendar. The follow up of their music listening activity was done during their regular visits to the hospital for antenatal check-up.

The effect of the antenatal music exposure was assessed in the babies born with spontaneous delivery or with elective caesarean section at full term to the mothers in both the music and non-music groups (n=352).

The newborn infants were assessed using the Brazelton Neonatal Behavior Assessment scale (BNABS). The BNABS is a measure helps assess the interactive behavior for babies born at full term and for stable preterm infants. The BNABS is grouped into seven clusters with relevant questions in each cluster. The seven clusters are habituation, orientation, motor performance, range of state, regulation of state and autonomic responses. The babies were assessed on the day two and three after birth by the investigator trained to administer the scale.

The results of the study showed that infants of mothers exposed to music performed significantly better on the 5 of the 7 BNABS areas as compared to infants whose mothers had no music exposure. The 5 areas were habituation, orientation, range of state, regulation of state and autonomic stability. In simple words, the infants showed better response to stimuli (auditory, visual and tactile), better regulation of behavior and more autonomic stability

2.3 Early Musical Training and White-Matter Plasticity, Steele CJ et al (2013)

In this study, the authors research if early music training can have an impact on the amount of white matter in the corpus callosum. They also postulate that music training during a sensitive period in development may have greater effects on brain structure and behavior than training in later life. According to the authors many highly skilled musicians have started their music training at a very

young age sometimes even before the age of seven. This could imply that music training in early childhood can have more effect on brain and behavior when compared with training in later life. This could mean that there is a sensitive period in early childhood when music training can have maximum beneficial effects on the brain and behavior. The sensitive period is a developmental window of opportunity during which the experiences that the child has can have long lasting effects on brain and behavior.

The hypothesis that was sought to be tested in this study was whether music training in early childhood can have an effect in improving sensorimotor integration by having an impact on brain plasticity in the white matter fibres that connect the motor and sensory regions of the brain. The study also sought to investigate the relationship between brain structure and sensorimotor synchronization performance. This would help to test if structural changes due to early music training could be directly connected to behavioral enhancements.

The participants in this study were thirty-six highly trained musicians. They were divided into two groups based on their age of starting their musical training. The musicians who started their training before the age of seven year were put into the early training group (ET) and musicians who started their training after the age of seven years were put into the late training group (LT). The ET group and the LT group consisted of eighteen participants each. The musicians were matched for other characteristics such as years of formal music training, number of years of musical experience and numbers of hours of current music practice. The musicians in both the groups had at least seven years of musical training. Another group of non- musicians (n= who had less than three years of musical experience and were not currently undergoing any musical training or practicing on an instrument formed the control group.

Diffuse tensor imaging (DTI) was used to compare the white matter structure between the early training group and the late training group. Motor timing and synchronization was assessed using the Temporal Motor Sequencing Task (TMST). The participants learning was assessed with two measures of performance.

The results of the study showed that early music training did have a differential impact on white matter structure and sensorimotor coordination. It was found that participants in early music training before the age of seven years (ET) had better white matter connectivity and sensorimotor integration when compared with participants in the late training group (LT).

2.4 Sound Stimulation and Brain Connectivity, Chaudhury S. et al (2013)

In this review study, the authors study the role of sensory stimulation in reprogramming brain connections in the prenatal period in birds and mammals. They discuss the role of auditory stimulation as a form of external stimulation during the prenatal period. Research studies have shown that auditory stimulation helped improve perceptual learning and even altering visual preferences in birds. Prenatal sound stimulation of bird embryos was found to improve their learning abilities postnatally. Prenatal and postnatal sensory stimulation was also found to influence perceptual ability and cognitive development in birds. Research studies on the role of environmental factors in stimulating brain development, the use of sound as a sensory stimulus, importance of sound in human beings and the effects of sound on the hippocampus are reviewed by the authors.

The review of research studies on environmental factors found that changes in neural connectivity can be modulated based on experiences. The changes in neural connectivity are more predominant if these experiences occur at a very young age. There was an improvement in the spatial memory abilities and behavior in young Wistar rats exposed to enriched housing. It was also seen that providing an enriched environment led to increased levels of brain-derived neurotrophic factor (BDNF) in the visual cortex of the brain. The BDNF has a critical role to play in improving neural plasticity during development. An enriched environment was also found to reduce anxiety and irritability in rats by reducing the serum corticosterone levels. Studies on human beings have shown that social deprivation can have long term negative consequences on social behavior and emotional stability.

A number of research studies have focused on the beneficial effects of the use of sound as a sensory stimulus. Research studies have found that sound stimuli can have a physiological effect on the respiratory rate, heart rate and blood pressure. Sound stimulation in children with autism was found to increase the level of oxygenated hemoglobin in the circulatory system supplying the prefrontal and temporal cortices of the brain. It has been proposed by some researchers that listening to music can help promote hippocampal neurogenesis, repair and regenerate nerves and improve brain plasticity.

Research studies demonstrate the development of hearing in the womb by the third trimester of pregnancy in human beings. There is a preferential increase in fetal brain activity to sounds that are typical to their species. Human infants show preference to certain types of sound stimuli when compared to other sounds. This selective preference to sounds in the environment may help consolidate their memory and preference to speech sounds. Stimulation with music was found to improve the functional plasticity of the hippocampus in adults. Background music was found to improve the cognitive abilities of students who were mentally challenged, healthy undergraduate students, adults and elderly adults with Alzheimer's disease.

The connection between the hippocampus and the auditory pathway are also discussed in this review. The similarities between avian brain and the mammalian or human brain are discussed. This means that studies on birds could to some extent be extrapolated in mammals and human beings. Studies on rats found that damage to their vestibular system could lead to a long-term effect on neurochemical and electrophysiological functions of the hippocampus. When rats were progressively exposed to noise for a period of six weeks, there was an impairment learning abilities and memory. There was an increase in spatial learning ability and hippocampal neurogenesis in rat pups who were exposed to music in the prenatal period. Exposure to noise that was non-musical in the mother's womb in rat pups led to decrease in hippocampal neurogenesis, growth retardation and impaired spatial learning abilities. Prenatal sound stimulation in chicks was found to improve the development of the hippocampus, enhanced spatial learning and perceptual preferences in neonatal chicks.

The conclusions of this study are that positive sound stimulation like the mother’s voice or music can help in improving brain function like learning and memory in infants. Music can have a beneficial effect not only in improving brain connectivity but also as a treatment modality for different problems such as autism spectrum disorders, Alzheimer's and so on. Appropriate sound stimulation can modify neural connections and also repair damaged connections. On the other hand, exposure to loud or unpleasant noise both prenatally and postnatally can have a detrimental effect on brain connectivity, development of the hippocampus, learning, memory and cognitive abilities.

3. Conclusion

The review of literature on the effects on music and brain development helps establish the fact that early exposure to classical music can be beneficial both as a background music intervention in the prenatal period and as an active teaching methodology. It was found that children who started learning music at young age had improved brain development and connectivity when compared to children with no music exposure. It could therefore be concluded that classical music should be included both as a therapeutic modality and as part of the school curriculum.

Acknowledgments

I would like to acknowledge the continuous support and encouragement of my Research Guide Dr. Alice Aloysius, MSc, PhD, Faculty and Student Counselor, Department of Psychology, Kristu Jayanthi College, Bangalore.

References

[1] Arya R, Chansoria M, Konanki R, Tiwari DK. Maternal music exposure during pregnancy influences neonatal behaviour: an open-label randomized controlled trial. International journal of pediatrics. 2012 Feb 14;2012.
[2] Bales DW. Building Baby's Brain: The Role of Music. University of Georgia, College of Family and Consumer Sciences; 1998.
[3] Chaudhury S, Nag TC, Jain S, Wadhwa S. Role of sound stimulation in reprogramming brain connectivity. Journal of biosciences. 2013 Sep 1;38(3):605-14.
[4] Gruhn W, Rauscher F. The neurobiology of music cognition and learning. The new handbook of research on music teaching and learning. 2002 Apr 18:445-60.
[5] Hepper PG. An examination of fetal learning before and after birth. The Irish journal of psychology. 1991 Jan 1;12(2):95-107.
[6] Kisilevsky BS, Hains SM, Jacquet AY, Granier-Deferre C, Lecanuet JP. Maturation of fetal responses to music. Developmental Science. 2004 Nov 1;7(5):550-9.
[7] Schellenberg EG. Music and Cognitive Abilities. Current Directions in Psychological Science. 2005 Dec 1:317-20.
[8] Steele CJ, Bailey JA, Zatorre RJ, Penhune VB. Early musical training and white-matter plasticity in the corpus callosum: evidence for a sensitive period. Journal of Neuroscience. 2013 Jan 16;33(3):1282-90.