

Influences of Music Training on Physical and Psychological Development of Preschool Children

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Abstract

Preschool children between the ages of three to six play a crucial role in the overall development of young individuals. This stage is marked by notable progress in physical, psychological, and intellectual development, along with the emergence and formation of emotions and personality traits. A large number of experimental studies investigated the effects of music training on preschool children's physical, cognitive and social development. In this study, we searched for previous relevant literature and used qualitative analysis to provide an in-depth analysis of how music training affects preschool children's physical and mental development. The findings demonstrate that music training has a profound impact on the physical and psychological development of preschool children, such as brain development, memory, creative problem-solving skills, auditory perception, and cognitive function. However, variations in the results were observed in different studies, and additional research is needed to determine the precise relationship between dose and effect of music training on the physical and psychological development of preschool children.

Keyword: Preschool Children, Music Training, Physical Development, Cognitive Development, Social Development

Introduction

Preschool Children, who are between the ages of three and six, play a crucial role in an individual's development due to the impact their experiences have on subsequent phases of learning and growth. The comprehensive growth of preschool Children is significantly enhanced when exposed to music during this stage, influencing their social, emotional, physical, and cognitive development. Understanding the functions and roles of music training is crucial, as it has a beneficial impact on the physical and psychological development of preschool Children, fostering environment conducive to their long-term growth. This study provides comprehensive insights for preschool educators by summarizing previous research and outlining three major domains (Figure 1) influenced by music training.

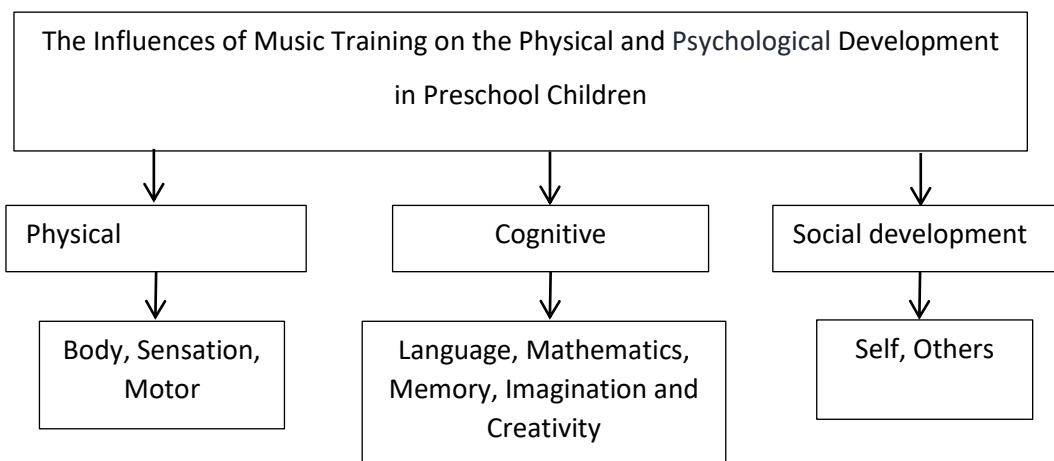


Figure 1: Areas of Physical and Psychological Development in Preschool Children

Influence of Music Training on Physical Development in Preschool Children

Brain Development

Scientific research consistently indicates that childhood plays a vital role in the development of the brain, emphasizing the importance of recognizing that distinct functional regions of the brain may experience growth at different rates (Pascual-Leone et al., 2005; Bengoetxea et al., 2012). The left hemisphere is generally responsible for language learning, understanding numbers, creating concepts, seeing temporal continuity, and analytical thought (Corballis, 2014). The right hemisphere is largely responsible for controlling tasks related to holistic thinking, music processing, visual perception, facial identification, spatial awareness, and distance judging (Xu, 2010). Fast growth occurs in regions of the brain that receive appropriate stimulation (Berk, 2004). Early experiences in childhood learning contribute to brain development, with music training plays a significant role in influencing this growth (Gordon, 2023).

It is widely recognized that music training has an impact on both the structure and function of the brain (Schlaug et al., 2005; Norton et al., 2005; Wan & Schlaug, 2010; Herholz & Zatorre, 2012). Bengoetxea et al (2012) suggest that music training at different ages may all have distinct effects on brain plasticity and cognitive development. Malyarenko et al (1996) found that children participated in one hour of daily classical music sessions for 6-months exhibited greater coherence in brainwave amplitude fluctuations across both hemispheres compared to the control group. Additionally, significant stability was observed in the amplitude of fluctuations specifically in the left frontal lobe of the brain for the experimental group. Based on these findings, the researchers concluded that the increase in brainwave amplitude enhances an individual's capacity to analyze and process information. It is evident that music, by influencing an individual's internal emotional state, can indirectly facilitate or hinder the learning process and the development of children's abilities. Hudziak et al. (2014) conducted a longitudinal study to investigate the correlation between the duration of music training and the maturation of individual cortical development. They found a significant correlation between music training and cortical maturation in the brain, specifically in regions such as the left dorsolateral prefrontal cortex, posterior orbitofrontal cortex, right middle frontal gyrus, and bilateral hippocampal gyrus. Watanabe et al (2007) showed that musicians who initiated their music training before the age of seven years performed better on a time motor sequence task when compared to those who started after the age of seven years.

In addition to age, it is crucial to consider the duration, extent, and type of training, as these variables can influence neuroplasticity. In the study by Flohr et al (2000), indicating that children between the ages of four and six who received 25-minute music training sessions for 7-weeks exhibited lower Beta power in posterior brain regions in the Partial Cognition Test (Wechsler's Object Assemble test). Hyde et al (2009) conducted a 15-month follow-up investigation involving in two groups of six years old children. The results revealed that experimental group (receiving general music education in the classroom and instrumental music training outside the classroom) exhibited significantly larger relative voxel sizes in specific regions of the brain, including the fourth and fifth segment/midbody of the corpus callosum, the right precentral gyrus in the motor hand area, and the right primary auditory region, in comparison to the control group (only receiving general music education). In addition, the experimental group demonstrated significantly better performance than the control group in assessments of both finger movement and music skill. Functional differences in the brain have been shown to be linked to the specific instrument played (Norton et al., 2005). For example, violin training has been associated with adaptations in brain regions that control movements in the left hand, while piano training has been associated with adaptations in brain regions that control finger movements in both hands (Amunts et al., 1997; Elbert et al., 1995). However, Pantev et al (2001) suggested that the observed brain attributes in musicians may be inherent rather than acquired through musical training.

Abovementioned studies demonstrated that engaging in rich activities and receiving comprehensive training are essential for promoting regular activation of all parts of the brain, thereby facilitating the optimal development of the brain's centers. The preschool stage undergoes fastest growth and development stage of the brain, during which the more opportunities there are for active activities involving all parts of the brain, the more likely it is that they will be fully developed. Therefore, it is only by placing emphasis on music training that it is possible to fully develop brain functions, providing a solid material foundation for the psychological development of preschool children.

Auditory Ability Development.

The preschool stage represents the period of most rapid development in auditory ability. One study revealed that 92% of individuals who began music education between the ages of two and four developed the ability to recognize absolute pitch (Xu, 2010). This percentage decreased to 68.4% for individuals who commenced their musical training between the ages of four and six, further declining to 41.9% for those between the ages of seven and nine years, and ultimately reaching a mere 6.5% for those who initiated musical education at the age of fourteen years (Xu, 2010). This findings indicated the existence of a crucial period during the development of human auditory capabilities, with the degree of auditory plasticity diminishes as age increases (Kral, 2013).

Research showed that the human auditory cortex reaches full development as early as in the mother's uterus, enabling the fetus to respond to sound during the first trimester of life (Moore et al., 2001). Moreover, fetuses possess the ability to perceive and recall musical sounds, potentially influencing their behavior after birth (Lecanuet, 1996). Additionally, Shahin et al (2008) demonstrated the positive effect of music training on the rapid development of the auditory system and the increased sensitivity to timbre in preschool children. Specifically, after one year of piano training, preschool children who listened to piano tones displayed enhanced oscillatory gamma band activity within the frequency range of 30-100Hz, whereas preschool children without piano training did not exhibit this effect

(Shahin et al., 2008). Furthermore, a study conducted by Norton et al. (2005) revealed that preschool children between the ages of five and seven who received music training exhibited superior auditory discrimination skills compared to those who did not undergo musical training. Electroencephalographic studies showed that changes in auditory stimulation of musical tones resulted in greater mismatch negativity in musically trained children compared to children with no musical experience (Meyer et al., 2011). This heightened processing of the auditory system is evident in three key domains: pitch, timbre, and temporal properties. Musical experience exhibits a positive correlation with enhanced aptitude in processing pitch, timbre, and time (Kraus et al., 2009). From this, it seems that musical training fosters the development not only of the processing of fundamental auditory components but also of the capacity to perceive higher levels of auditory regularity.

Motor Skills Development

Preschool Children represent a crucial phase of physical ability development, during which a wide array of fundamental motor skills is established (Robinson et al., 2015). The World Health Organization and other countries have issued guidelines on physical activity for young children (World Health Organization, 2019; Ministry of Education of the People's Republic of China, 2012; Timmons et al., 2007; Okely et al., 2017; Payne et al., 2013). The progression of gross motor skills in preschool Children not only enables them to accomplish daily physical activities but also serves as a foundation for the future development of fine motor skills and complex motor skills (Foweather et al., 2015).

During childhood, music and physical activities are widely enjoyed and have profound effects on early education and social interactions (Chen-Hafteck, 1997; Mark, 2002; Mithen, 2005). Music often triggers instinctive physical reactions like nodding, wiggling, finger snapping, and stepping. Furthermore, music is often accompanied by distinct rhythms and beats, which can promote preschool Children to synchronize their movements with the music when dancing or using percussion instruments. Moreover, music education comprises a spectrum of movements, ranging from simple finger motions to whole-body gestures. Derri et al. (2001) investigated the impact of a 10-week music and exercise intervention on the physical performance in a group of preschool children between the ages of four and six. The findings revealed that children who engaged in twice-weekly exercise showed significant improvements in running, jumping, and long jumping abilities when compared to those who did not participate in any organized physical activity. Zachopoulou et al. (2004) found that combined music and exercise programs significantly improved preschool children's motor skills and dynamic balance compared with a standard physical education program without music.

Influence of Music Training on Cognitive Ability Development of Preschool Children

During Piaget's era, cognition was perceived as a comprehensive structure, wherein the development of cognitive abilities such as memory, perception, and comprehension were interconnected and synchronized. Piaget's theory posits that young children predominantly engage in thinking through action, and that the majority of their cognition occurs during the "preoperational stage" (Piaget & Cook, 1952). During the neo-Piagetian era, extensive research and subject matter observations emphasized the significance of domain identity (Carey, 2011; Chen et al., 1998; Chen et al., 2009). These studies indicated that cognitive abilities are closely tied to specific domains. For instance, a child experiencing difficulties in reading and writing may not necessarily face the same challenges in drawing or music.

Similarly, a child talented in math may not excel in other domains. In essence, preschool children's development tends to vary across different domains (Chen & Gardner, 2012; Kunkel, 2009).

Language Ability Development

Music and language are both part of the auditory system, they share many auditory and cognitive resources. Language development is in a critical stage of rapid growth in childhood, and music often accompanies language learning (Yu, 2013). More and more evidence suggested that actively engaging in music enhances phonological skills. One study conducted by Peynircioglu et al (2002) who found that preschool Children with higher musical aptitude exhibited better control over speech. Furthermore, Anvari et al. (2002) found a significant association between musical skills and both phonological awareness and reading development. Mizener (2008) argued that musical activities enhance multiple facets of language development. Preschool children who took part in an interdisciplinary program that incorporated music and their native language exhibited more effective improvements in phonological awareness, vocabulary recognition, and spontaneous spelling compared to those who did not participate in such a program (Bolduc, 2006; Register, 2001; Standley & Hughes, 1997). Moreno et al (2011) compared two interactive computerized training programs, music and visual arts. After 20 days of training, the music group exhibited substantial enhancements in verbal IQ test scores, with 90% of the preschool children had such improvements. In line with prior research, Bolduc et al (2021) found that music training significantly facilitated the development of inhibitory control and phonological processing. In the study of Patscheke et al (2016), after 16 weeks of three 20-minute weekly sessions, the pitch-only group exhibited noteworthy enhancements in larger units of phonological skills (i.e., syllables and rhymes); the rhythmic group demonstrated only modest improvements in phonological awareness skills, and no significant differences in phonological skills were observed in the motor group.

It can be concluded that music training can promote phonological perception, improve phonological awareness, and then improve phonological functioning. Some researchers have initially carried out music training-based interventions in groups of children with delayed speech development, and the preliminary results support the hypothesis that music training improves phonological ability and enhances speech comprehension (Groß et al., 2010). In contrary, several studies compared the combination of music and phonological skills training and phonological training alone. Kempert et al. (2016) did not find any significant effects of music training, possibly due to the low efficacy of the test, this difference did not reach a significant level. Forgeard et al. (2008) found no difference in the number of words remembered between two groups.

Mathematics Ability Development

It has been recognized that there is a significant correlation between music and mathematics (Vaughn, 2000). Mathematics is involved in various aspects of music, including notation, performance, rhythm, phrasing, harmony, and composition. However, it should be noted that not all aspects of music are directly related to mathematics. Several studies have demonstrated that different music training programs improved preschool children's mathematical abilities, such as Montessori training (Harris, 2007), the Orff-Schulwerk (Whitehead, 2001), the Kodaly method (Courey et al., 2012), Music and Drama Teaching Mathematics Methods (Erdogan & Baran, 2009), and learning to play musical instruments

(Haley, 2001). Abovementioned studies consistently indicated that young children who receive music training achieve higher levels of mathematical proficiency compared to control group. Furthermore, in an exploratory study conducted by An et al. (2013), the results revealed that the integration of music into a mathematics curriculum positively influenced mathematical ability across various domains. Geoghegan and Mitchell (1996) investigated the effects of a music program on the mathematical performance of preschool children. The findings indicated that preschool children who engaged in musical activities scored higher on a mathematics achievement test compared to preschool children with no musical experience. Moreover, Raja and Bhalla (2021) reported that preschool children who received carnatic vocal music training significantly improved their mathematical ability (assessed by The Test of Early Mathematics Ability-3 (TEMA-3)) compared to the control group followed a standard curriculum.

However, Rafferty (2003) found that music training did not have a significant effect on the mathematics performance for second graders. The findings may be attributed to the specific type of musical activity and the intervention duration. Similarly, Mehr et al. (2013) demonstrated that preschool music programs did not improve mathematical skills. The study revealed a substantial enhancement in mathematics performance when music was actively engaged with. In contrast, passive listening to music demonstrated only a marginal improvement in mathematics performance. Thus, it is plausible to infer that actively participating in music-making and learning to apply music positively influences mathematical ability. However, the specific mechanisms involved, the type of music training, and the required duration for improvement remain unclear.

Memory Ability Development

Musical memory, as a part of music psychology, has gained considerable attention from researchers since the inception of music psychology as a distinct discipline in the early 20th century. Researchers conducted numerous studies examining the impact of music on learning and memory. These studies consistently demonstrated an enhancement in learning outcomes and skill levels from music training (Elyse et al., 2011).

Sun et al. (2013) investigated the neural mechanism underlying the influence of music on working memory and found enhanced working memory from music training. However, there was no significant difference in event-related potential technique. Li (2015) analyzed the differences between preschool children who underwent literacy, auditory and choral training and untrained preschool children on visuospatial template system, phonological circuit system, and central executive system. The results showed a positive correlation between music training and enhanced working memory capacity in preschool children. Moreover, research have consistently demonstrated that musical stimulation promotes the utilization of memory potential. Lozanov (2004) developed a technique known as "suggestology," which involves synchronizing the learning content with baroque music played at a tempo of 60 beats per minute. Experts demonstrated that this method can enhance mechanical memory by up to 50%. The phenomenon known as the "Mozart effect", which was first identified by Rauscher et al. (1993). They proposed the idea that the brain employs a neural triggering model in the processing of information, highlighting the interplay between music and neural pathways. Although these hypotheses await further confirmation through additional research, it is reasonable to assume that certain types of music have a positive impact on an individual's physiological state.

Imagination and Creativity Ability Development

With the ever-increasing competition in science and technology, most countries in the world regard creativity as one of the core competencies in the competition for talents (21st Century Skill Maps, 2013; Malaysia, 2013). According to Kokotsaki (2012), creativity entails the utilization of original thinking and imagination in problem-solving. One study found that the advancement of preschool children's creative thinking is influenced by age (Torrance, 2000). Specifically, they observed that creativity developed at a fast pace between the ages of three and five, but the rate diminishes after the age of five (Torrance, 2000). Due to the distinct influence of music training, fostering musical creativity is recognized as a vital objective in music instruction.

Compared to other forms of music training, fewer studies have explored the effects of musical creativity (Hallam, 2010). Kalmar (1982) reported that preschool children who participated in singing and musical group performances exhibited higher levels of creativity compared to a control group that did not receive such instruction. Additionally, they demonstrated greater levels of abstraction and showcased enhanced creativity in improvised puppetry. This is further demonstrated by the research of Koutsoupidou and Hargreaves (2009). In their 6-month study involving preschool children aged six, showed that the experimental group (a range of improvisation activities) demonstrated higher levels of musical flexibility and creativity compared to those in the control group (traditional music lessons). Furthermore, Peng et al. (2021) reported that Orff music game group obtained higher scores than the control group across various dimensions of the Torrance Test of Creative Thinking Volume A Drawing scale (TTCT-A), including total score, fluency, originality, delicacy, and contemplation after 16 weeks intervention in a group of preschool children between the ages of five and six. Bačlija Sušić and Brebrić (2022) assessed sound and musical creativity in a group of preschool children between the ages of five and six. The findings indicated that carefully crafted and stimulating musical activities not only foster preschool children's musical creativity but also contribute to the identification of their musical potential and talent.

Influence of Music Training on Social Ability Development of Preschool Children

The period from birth to five years of age is widely acknowledged as a critical developmental window for the acquisition of social and prosocial skills (Ilari et al., 2021). The quality and quantity of preschool children's social interactions during this developmental stage significantly influence their lifelong social development. Music plays a crucial role in facilitating interpersonal engagement and satisfying the innate human need for social interaction.

A variety of research showed associations between long-term participation in music training programs, social and pro-social skills and community building (Adderley, Kennedy, & Berz, 2003; Dagaz, 2012; Eerola & Eerola, 2014; Rzonza, 2016). These studies consistently demonstrated that sustained involvement in collective musical activities promotes cooperation, strengthens an individual's sense of belonging and group affiliation, and ultimately contributes to pro-social development. Harland et al. (2000) demonstrated the correlation between arts participation and students' personal and social development. Kirschner and Tomasello (2010) also found that four years old preschool children engaged in musical play exhibited greater willingness to cooperate with their peers compared to those who engaged in play without music. Similarly, Beck and Rieser (2020) showed that preschool children between the ages of three and five displayed more helpful behaviors towards

researchers after participating in a music training. Boucher et al. (2021) found that the social interaction and independence skills of younger children showed improvement, the co-operation skills of older children displayed a decline. Furthermore, the older children demonstrated enhanced emotional understanding. However, the study of Ilari et al. (2020) found no notable age or gender differences in preschool children's pro-social responses. Additionally, it demonstrated a positive correlation between instrument sharing and the duration of participation in the music program.

In contrast to the aforementioned findings, Kirschner and Ilari (2014) found no association between short drumming sessions and pro-social skills in preschool children between the ages of three and five. Additionally, Alemán et al. (2017) found no impact on pro-social behavior from the El Sistema program involving students. Similarly, the research by Ilari et al. (2018) revealed that a brief 5-week music program did not yield positive effects on preschool children's pro-social skills, such as sharing and helping. Therefore, in order to effectively enhance social skills development in preschool children through music training programs, it is crucial to incorporate breaks from traditional group settings, offering opportunities for preschool children to engage in activities that exercise their social skills.

Music has a significant potential to foster positive social development in individuals. It is worth noting that the types of music training influence preschooler's helping and sharing tendencies. Specifically, the concept of "musical interaction" which involves active and effective engagement with the music, including outwardly perceived body movements. Secondly, different types of music training are distinctive, so not all of them give young children the opportunity to interact effectively with music through their bodies. Overall, different types of music training do not require the same demands on learners, nor do they have the same opportunities for musical interaction, which creates differences in the impact on preschool Children' pro-social behaviour.

Conclusion

The current studies consistently demonstrated that music training has a significant positive impact on preschool children's brain development, including memory, creative problem-solving, auditory perception, and overall cognitive development. However, the impact of music training on preschool children's development is influenced by a variety of factors, such as types of music training, duration and intensity of music training, quality of instruction, and individual differences. The ability of experimental research to effectively control extraneous variables in order to ensure that the results of the study are true and valid is something that needs to be further verified. Furthermore, there also exists controversy results. For instance, variations in interest and motivation contribution to differences in the performance of preschool children engaged in music training. Additionally, there are disagreements regarding the impact of the duration of music training on performance. There are studies that prove that short-term music training did not yield significant improvements in spatial reasoning and intelligence among preschool children (Schellenberg, 2006). However, several researchers considered that short-term music training can yield certain positive impacts on individuals (Pascual-Leone et al., 1995; Moreno et al., 2011). Consequently, further investigation is warranted to explore the dose-effect relationship between music training.

The significance of this study stems from its thorough examination of the distinctive attributes of musical training on the physiological, cognitive, and social aspects of preschool children. This not only broadens the theoretical foundation of music education for preschool children but also underscores the positive impact of music education on preschool children's

development and social integration. This study not only provides educational practitioners with a theoretical basis for designing more scientific and inspiring music education programs for preschool children, but also provides parents with important references for choosing appropriate educational approaches in the early stages of children's development. Hence, this study not only contributes to the enhancement of future research on music education but also aids in optimizing the educational practices for preschool children.

Recommendations

The impact of music training on individuals' developing to elucidate the long-term impact of music training. Therefore, future research should prioritize conduct that is influenced by the extent of duration. Most studies not included follow-up assessments, thereby feigning comprehensive investigations into the sustained effects and transferability of music training. Additionally, the differences of various age groups should also be examined. These information will enable educators to design programs tailored to the specific needs of preschool children at different developmental stages. In addition, whether the effect of musical training on people is related to musical talent, further long-term studies could consider children's musical talent as an aspect to be examined.

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