THE IMPACT OF MUSIC EDUCATION ON STUDENTS' COGNITIVE DEVELOPMENT OF CREATIVITY IN ELEMENTARY SCHOOLS

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ABSTRACT

Music education in the elementary ages of a child's life has proven to be connected to cognitive outcomes. However, how it influences a child's creativity is a field that has not been thoroughly researched. Understanding the impact of musical education on a child's neurological development and creativity is paramount to gaining a holistic understanding of cognition in children. Literature exploring the development of divergent thinking, executive functions (EF), and neurological functioning from music training provides insight into the multiple ways that music impacts cognition. Databases including OVID Medline, ScienceDirect, and PubMed were searched , and the CRAAP test was used to assess validity. Findings suggest a strong positive correlation between high intrinsic motivation levels among students in music education and divergent thinking skills. Neuroimaging results pointed out an underlying co-activation in the Inferior Frontal Gyrus, a brain region associated with divergent thinking and creative idea generation, particularly evident during musical improvisation [1]. Results also indicate varying strengths in associations between music training and the development of three EFs (working memory, inhibition, and cognitive flexibility). Greater cognitive flexibility and lesser inhibition are also correlated with creativity, thus demonstrating the need to further research the relationship between EFs, music education, and creativity. Musical education is also associated with increased cognitive functioning, including auditory processing, reasoning, and language abilities. Additionally, certain styles of musical education are hypothesized to increase perseverance and attention. Such findings imply that further research can be done to understand the mechanisms through which musical education impacts creative thinking in children and would be useful for further applications of musical education in educational and recreational settings.

INTRODUCTION

Within multiple theoretical frameworks that pertain to the evolution of children, the concept of creativity is found intricately weaved into the field of cognition. For example, in Piaget's theory of cognitive development, the emergence of symbolic and imaginative play is seen in the preoperational stage that is often associated with ages 2-7 – two concepts which are associated with creativity [1]. In Vygotsky's sociocultural theory, a child's interaction with their cultural surroundings is hypothesized to shape their cognitive development [2], and a child's creative abilities evolve with increased life experiences [3]. Defined by Li as "the ability to generate novel and potentially useful ideas or solutions to problems" [4], creativity in education, or the lack thereof, has become a prominent concern due to heavy reliance on test scores (i.e., IQ scores) within the elementary school curriculum [5]. The elementary school grade range is defined from kindergarten to grade 8 (approximately ages 4 to 14) [6]. To further opportunities and increase experience for students in creative expression, artforms such as music, drama, dance, and visual arts have been pushed to be integrated into early childhood education [7]. Particularly, the instrumental side of music education has been recognized for its notable influence on an individual's cognitive development. For example, according to Chan et al., adults who have had at least 6 years of musical training before the age of 12 recalled approximately 16% more words than those without, proving greater verbal memory [8]. However, literature on the relation between music and cognition in traditional education is still considered novel, and consequently under-addressed. Thus, this review aims to explore the impacts of elementary music education on children's divergent thinking, executive functions, and neurological functioning to elucidate how musical training can influence a child's cognitive development of creativity.

METHODS

In pursuit of our objective, we conducted a comprehensive database search associated with music education and its relations to traditional elementary education and cognitive-creativity development. Databases including OVID Medline, ScienceDirect, and PubMed were searched , and boolean operators were employed to ensure data relevancy and accuracy. MeSH terms were also integrated to increase specificity and filter large quantities of database results, with search terms pertaining to elementary education, children's cognition, and musical training. To ensure reliability, citations were reviewed and assessed using the CRAAP test. Recovered literature was separated into article types, such as trials or opinion articles, to ensure separation of factual evidence from personal perspectives. For the review's inclusion/exclusion criteria , regarding exclusion, articles outside of North America (i.e., Canada, United States) were not included, with exception of literature from the United Kingdom and Hong Kong that were only included to add details to the current evidence discussed in this review. With regards to the inclusion criteria , only studies from 1991 to 2023 were incorporated into the review to cover a broad spectrum of findings and trends relevant to our objective.

DIVERGENT THINKING

Introduction to Divergent Thinking

The ability of Divergent thinking (DT) is considered an educational skill that is pronounced in younger children and decreases with age. It is a critical component in developing creative thinking. DT involves the use of a thought process that enables students to scan a problem or concept from multiple directions, helping them to free-flowingly generate solutions [9]. It differs from convergent thinking, which seeks a single correct answer, by encouraging exploration of various perspectives and unconventional ideas.

Experiment on Divergent Thinking: Impact of Intrinsic Motivation

A study by Wolfe et al. investigated intrinsic motivation and divergent thinking in music education within forty Midwestern third graders who demonstrated high convergent ability [10]. They measured the children's Intrinsic Motivation Level (IML) by observing time spent engaged in music-making.

The results indicated a statistically significant relationship between intrinsic motivation and divergent thinking. In divergent thinking challenges, students with higher IML scores outperformed those with lower intrinsic motivation levels. Specifically, the High Intrinsic Motivation group (HIM) scored significantly higher on the Measures of Creative Thinking in Music Tests (MCTM) compared to the Low Intrinsic Motivation group (LIM) ($t = -2.79$, $p < .01$). These findings suggest that intrinsic motivation crucially enhances divergent thinking.

Improvisation in Music Education - Benefits and Integration

As technology progresses, North American elementary music education reflects other aspects of divergent thinking. This is seen through varying experiments showcasing musical improvisation as a core component of North American music education curriculum . Pedagogical approaches such as the Kodály Method further establish its importance [9,11]. Notably, a study by Lewis examined divergent thinking scores of instrumental music students in the United Kingdom with improvisation instruction and observed an increase in divergent thinking for fluency, originality, and flexibility [9]. Contrastingly, the control group had no increase in DT, suggesting that improvisation can encourage individuals to break from schemas. This finding potentially extrapolates to North American practices due to the shared use of the Kodály Method.

Moreover, neuroimaging studies captured in reviews by Sowden et al. have consistently shown activation in the Inferior Frontal Gyrus (IFG) during musical improvisation, an aspect of the brain that is connected to forming creative ideas via divergent thinking [12]. In addition, Beaty et al.'s research demonstrated statistical significance in divergent thinking, predicting 57% of the variance in expert judgment regarding the creative quality of improvisation [13]. The co-activation of IFG suggests a common mechanism that underlies divergent thinking and musical improvisation.

EXECUTIVE FUNCTIONS

Executive functions (EF) are a group of cognitive operations that lead to purposeful and goal-oriented behaviors. They recruit several brain structures, particularly among the prefrontal cortex [14,15,16]. EFs play a critical role in an emerging child's cognitive development as they contribute to learning and behavior [15]. Furthermore, there are 3 core brain functions that make up executive functions in children: inhibition, working memory and cognitive flexibility [14]. Inhibition encompasses a child's ability to resist impulsive actions [14,15]. Working memory (WM) is defined as the capacity to retain information over short time durations while also achieving other cognitive tasks [14,15,17]. Lastly, cognitive flexibility is the ability to shift attention between different behaviors and mindsets, especially in adapting to change [14,15].

The systematic review by Rodriguez-Gomez et al. evaluated various EFs in three age groups: preschool, school-age, and adolescent [14]. Among these categories, 23 studies yielded results on inhibition, 19 studies yielded results on WM and 17 studies yielded results on cognitive flexibility. The authors identified a greater benefit of music training in inhibitory control while there

were more mixed results for the remaining 2 core EFs. Studies evaluating the relationship between music training and inhibition ranged from a variety of methodologies including Go/No-Go, Stroop, Simon, and the NEPSY tests. These tests are cognitive and neuropsychological assessments designed to evaluate key aspects involved in executive function such as inhibition, selective attention and cognitive control. For instance, in a 2021 Canadian study examining 50 children, children in the non-music intervention group demonstrated greater progress in NEPSY inhibition than in the corresponding control and motor groups. Authors hypothesize that the role of attention, control, and integration of multiple sensory stimuli in music training contribute to this positive trend. Additionally, three of eight studies examining working memory yielded positive results in preschool children while the remainder of studies involving school-age children and adolescents did not identify significant differences between music and control groups.

A similar trend was observed in the case of cognitive flexibility. Some studies in preschoolers were able to identify statistically significant improvement in several cognitive tasks (DCCS, WCST, or the NEPSY-II subtest: "Animal Sorting.") while no associations were found in larger sample sizes of adolescents and school-aged children. Moreover, the studies which focused on preschool children exhibited a relationship between music training and EF development. However, improvements were found to decline with increasing age, especially among adolescents. This can be partly attributed to the extensive maturation and overall neurodevelopment occurring during the ages 3-5. More research can help better explain the effect of age on EFs and music training. In addition, it is important to consider that there exist several challenges in this field of clinical research as the definitions of music education can be variable from study to study and certain variables are not standardized such as measures of creativity. Overall, the complexity of these results can be clarified with further research and new hypotheses examining more focused types of music education.

A 2023 systematic review by Pasarín-Lavín et al. elaborates on the relationship between EFs and creativity in children and adolescents [18]. A number of papers demonstrate that creativity is positively correlated with flexibility and negatively correlated with inhibition. Authors suggest that this is because a person with lesser inhibition and greater flexibility demonstrates a higher creative capacity. In comparison, there was insufficient evidence to support a relationship between working memory and creativity. Authors also highlighted the need for standardized tests as the variability between studies can limit the conclusions made. Limitations included potentially objective measures of creativity, a limited article sample and a risk of publication bias demonstrated by the overwhelming positive results in research literature.

All in all, the results from the systematic reviews conducted by Pasarín-Lavín et al. and Rodriguez-Gomez et al. emphasize the implications of this field of research on a child's development as there is a complex interplay between a child's education and cognitive skills.

NEUROLOGICAL FUNCTIONING

Music engages the brain in a variety of ways, and the cognitive abilities that it develops can be transferred to other domains of creative thinking and neurological function via transfer effects. Evidence collected by Hille et al. Has shown an association between musical education and higher cognitive functioning. Specifically, their data suggests an association between musical training, general abilities, and spelling abilities [19]. In a retrospective study observing children between the ages of six and eleven, Schellenberg et al. observed a correlation between full-scale IQ scores and academic performance in children who received keyboard or signing lessons (20). In the study conducted by Forgeard et al. observing eight-to eleven-year-old children, it was .found that children who had received three years of music training performed better than the control group in the assessment of fine motor skills and melodic discrimination. Furthermore, results from this study suggest a correlation between receiving musical training during childhood, and increased IQ levels, academic performance, vocabulary size, and reasoning scores [21]. Schellenberg et al. examined the impact of music lessons on enhancing an individual's sensitivity to emotions. The ability of six-year-old children to identify anger and fear was studied, and it was observed that children who received one year keyboard lessons performed better than children who received no lessons [22]. Musical training impacts the development of auditory processing in the auditory cortex, which may explain the findings that Fujioka et al. observed between musical training, general intelligence, and auditory processing in four to six-year-old children. Children with musical training exhibited differences in the processing of violins sounds, which was demonstrated by a pronounced morphological change in neural responses during a time frame of 100ms to 400ms. This research suggests that children training under the Suzuki method may develop more advanced skills, or an increased abilities to sustain focused attention [23].

DISCUSSION

Divergent Thinking

Previous studies, such as Wolfe et al.'s, have questioned the reliability of divergent thinking's testing approaches [10]. Alternative methods of assessment (e.g., product rating) may be further explored to measure complex constructs like musical creativity to increase reliability. The variability of the grading system between elementary

schools suggests a future researchable sector on the impact of music education's extrinsic rewards (e.g., grades and awards) on students' divergent thinking.

Although there have been previous studies establishing that IFG's pre-activation affects how the brain processes stimuli [11,13] , there are limitations;untested approaches within Sowden et al.'s study [12]. Acknowledging research gaps, these assumptions are: (1) that other types of improvisation besides musical improvisation similarly activate the IFG, and (2) pre-activation of the IFG during musical improvisation is long enough to influence subsequent divergent thinking tasks. This paper, Sowden et al., helps guide our approach by linking IFG activation to divergent thinking, which we examine through musical improvisation—a spontaneous process often associated with creative thinking. Longitudinal neuroimaging research, which assesses the duration of IFG activation, could provide validation but faces challenges such as a lack of a golden-standard model and interpreting complex growth patterns [24]. Tackling these challenges is key to advancing developmental cognitive neuroscience.

Executive Functioning

This review clearly indicates the complexities of a child's creative cognitive development in relation to music education [14, 18]. In current research literature, the relationship between EFs and creativity ha s been explored separately to EFs and music training. A beneficial impact of music training on inhibition was identified while a lesser impact was noted concerning cognitive flexibility and working memory [14]. Overall, there is an age-dependent trend of the benefits of music training as the strongest associations were demonstrated in preschoolers while weaker associations were shown in adolescents [14]. This calls for further research to be conducted to better understand this trend and the broader implications of a child's musical experiences on their cognitive development in their early life. It was also found that greater cognitive flexibility and lesser inhibition are correlated with creativity [18]. These mixed findings demonstrate the advantages and drawbacks of certain cognitive functions, especially inhibition.

Additional research in this emerging field can help make clearer connections between EFs, creativity and music training. This can have more meaningful implications for the design and execution of education programs in promoting optimal cognitive development. Nevertheless, the studies from both research questions had many of the same limitations, primarily the lack of standardization of variables [14, 18]. This can be found between cognitive testing strategies, follow-up times, music training times and key definitions. Thus, standardization can allow researchers to make more generalizable and reliable conclusions. In addition, it is beneficial to explore varying frameworks of creativity to improve the accuracy of data in testing hypotheses amidst several proposed models. This can help limit objective measures while gaining greater perspective on the research question at hand. It is also important to recognize how this field of research is of relatively new interest and thus presents gaps in knowledge. Thus, it would be beneficial to further explore these associations between music education, creativity, and EFs.

Neurological Functioning

There is extensive research comparing groups of children receiving music lessons to groups of children receiving different types of enrichment, such as sports, or to control groups who are not engaging in any type of enrichment [20]. Thus, the opportunity to compare and contrast the differences that exist between the impacts that different instruments have on cognition may be easily missed.

Though there is extensive research that compares children trained in music to those untrained, there is limiteded research to justify which instruments in music facilitate a larger impact on a child's cognition [21]. Additionally, many studies investigating the impacts of music on cognition often have correlative results, and do not present causal relationships [19,20,21]. Causal relationships are more reliable than correlational when making evidence-based conclusions. This may be due to difficulties limiting a study's confounding variables within this field. It can be hard to isolate intelligence as an outcome when factors such as family situation, income level, genetic predisposition, health condition, mental well-being, and the presence of learning disabilities may all impact a child's mental abilities, and therefore impact the way that their intelligence levels are perceived by researchers.

Another limitation observed in this topic is the challenge to standardize and interpret cognitive outcomes and measurements that quantify cognitive improvement. There are various outcomes observed, such as IQ scores and the completion of tasks involving detection and recognition of patterns, such as auditory discrimination [20,21]. Furthermore, many of the studies we consulted which examine the impact of music on cognition often have small sample sizes, which can reduce the generalizability of the findings [21,22]. Across this literature, there is a lack of standardization on what quantifies a music lesson, making this subject difficult to generalize. Factors such as the consistency, frequency, structure, objectives, and presence of an instructor are all things which should be considered when trying to determine the quantification of a music lesson.

Lastly, there is a wide range of research investigating the effect of music on outcomes like IQ and auditory discrimination, as they are easier to test for and quantify [21]. However, there is minimal research focusing on the impact of music on a child's creativity, making this a challenging area to measure amongst students.

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