Music's Influence on Children's Cognitive Development

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Abstract. The purpose of this paper is to explore how music affects cognitive abilities by reviewing some experiments and tests that the investigator has done in the past. Executive functions are the abilities of a person to have new behavior patterns and ways of thinking, which are very important in children. Music can affect executive function. Also, IQ can be affected as well. Logical-mathematical ability can be affected by music. Also, another reason for writing this paper is to let society and the education sector realize that music lessons are important subjects, because in some Chinese schools, for some senior students, teachers take away the optional courses and change them into compulsory subjects. Future research should expand the age range so that the results might be more accurate. Also, use a general term for the tests used because sometimes there are too many of them, so using a general term would be better.

1 Introduction

Music education is when people learn to play an instrument or basic things in music, such as training their ears to have perfect pitch or relative pitch and learning the theory of music or some history. It is essential for children to learn music nowadays, as many children are now very stressed because they have too much pressure on them, and music is a way to let them relax. Music is not a compulsory subject in many schools, so most of the music lessons in primary schools do not teach the theory of music; the teachers might let the student play music for most of the time, which means letting the student sing or play the drum together, or letting the student make a band by themselves and create some music. Compared to other subjects like mathematics and English, music is more relaxed and fun to learn. Also, when children perform the music, it can make them more confident to be on the stage. For some children, music may be a way to express themselves, which means if the children are angry, anxious, or not feeling very well when they start playing the music, it may calm their nerves.

Music can not only let the children relax, but also it can improve their cognitive abilities. However, some previous research papers have not gone through it deeply. So, the purpose of this paper is to summarize previous studies to inquire into the question of whether music can affect children's cognitive abilities. This study aims to explore whether music affects cognitive abilities. And some other abilities, including IQ, logical-mathematical abilities, executive function, prosocial behavior, verbal memory, and how Mozart's music affects children's reading.

2 Executive functions

2.1 The meaning of executive functions

Executive functions are the intricate cognitive processes that empower individuals to adapt to new situations and improve their response to unprecedented circumstances. With the multitude of unique scenarios presented in everyday life, executive functions play a crucial role in a variety of behaviors. They are employed when strategizing for the future, switching between tasks, and exercising self-control [1].

2.2 The go/no-go paradigm

The go/no-go paradigm focuses on the brain's capacity for quick decision-making and measures information processing. Geometric forms were shown on a computer screen in a random order while a 64-electrode electroencephalogram was being recorded [2]. A white triangle, a purple triangle, a white square, and a purple square made up the set of four stimuli [2]. Go trials were signaled by all white stimuli, and no-go trials were indicated by all purple stimuli. Each trial starts with a black backdrop with a white cross that appears for 500 to 1000 ms on average before a form appears in the middle of the screen for no more than 500 ms. On go trials and no-go trials, the participants had to press a key. The trials were separated by 500 ms of blank screen time [2].

3 The effects of music on different abilities

3.1 Training in music's influence on executive functions

Music education can affect executive functions, and there is a test to investigate executive function after

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having a short music training program [2]. Seventy-one kids between the ages of four and six were the volunteers, but only sixty-four of them took part in the experiment since three of them quit completing the tests, two of them were unwell, and the other two couldn't speak English well. Twenty girls and twelve boys participated in one group that studied music, and thirty-two kids from the other group studied visual art. Sylvain Moreno was the one who developed the music training course. The curriculum combines physical, perceptual, and cognitive activities and involves instruction in rhythm, pitch, melody, voice, and musical ideas. The experiment was set up with three phases: the pre-test, the training phase, and the post-test [2]. The Wechsler Preschool and Primary Scale of Intelligence (WPPSI-III) [3] and go/no-go activities were finished at the pre-test and post-test. Children took the two examinations separately, and the group participating in the music program was subsequently given music lessons.

As a consequence, more than 90% of the children who participated in the music program had an increase in their verbal scores from the pre-test to the post-test [4]. Music instruction also increased IQ scores, which were evident on the verbal test. Additionally, following training, the music group's peak in the no-go trial was higher. By calculating the Pearson correlations between the change in verbal intelligence score and the change in peak amplitude, it was discovered that only the music group had a significant positive correlation between executive function and improvement in IQ scores.

3.2 The effects of music on IQ

Taking music lessons can increase IQ, and a test has been developed to support this claim [5]. The participants were six-year-old kids, who were chosen because they were old enough to participate in formal education and because their brains were less plastic than those of the older kids [6]. For this experiment, 144 kids were used, and they were placed into four groups at random. Two groups—the control group—received standard keyboard or Kodaly voice instruction over the course of a year. The students in the control group will take piano lessons the following year, but they either got theatrical instruction or none at all. Only 132 students completed the experiment since 12 kids dropped out of the lessons [5]. The process involved teaching kids for 36 weeks at Toronto's Royal Conservatory of Music. They were assessed using the full-scale IQ, which includes the four "index scores" of verbal comprehension, perceptual organization, freedom from distraction, and processing speed. Additionally, there are 12 sub-tests that cover the following topics: picture completion, information, coding, similarities, picture arrangement, algebra, block design, vocabulary, object assembly, comprehension, symbol search, and digit span. The K-TEA also includes five more sub-tests, including mathematical applications, reading decoding, spelling, reading comprehension, and mathematical computation [5].

The findings showed that, compared to the control group, both music groups had higher increases in full-scale IQ. The music group saw a greater increase in each of the four index scores, according to a two-way mixed-design analysis of variance. Additionally, the K-TEA exam and its twelve sub-tests showed a greater improvement in the music groups [5].

3.3 The effects of music training on logical-mathematical abilities

Research has looked at how musical training affects kids' logical and mathematical capabilities, and a wide range of research has shown that it has a favorable effect [7], such as helping kids grasp proportions and ratios in math [8]. Vaughn has created a test to see how music instruction impacts logical and mathematical skills. Twelve boys and eight girls between the ages of 4 and 6 made up the subjects, who were split into experimental and control groups. The control group only got instruction from the public kindergarten, which does not use formal methods for teaching music, whereas the experimental group began attending the Music School of Fiesole during their after-school hours. The music program was put up by the instructors of the Music School of Fiesole, who employed two distinct teaching philosophies: the Suzuki method [9] and the Rolland method [10]. Play and imitation were used as teaching strategies in the Suzuki approach. The Rolland technique emphasized movement, customized instruction, and the growth of musical originality. The course was broken up into two sections: didactic and preparatory. All of the kids participated in the singing and rhythm training classes; keyboards were utilized the remaining 20% of the time, and string instruments were used 80% of the time.

The findings suggest that musical instruction may help preschoolers develop their logical and arithmetic skills. Logical capabilities, serialization, counting, categorization, and notation abilities all improved.

3.4 How Mozart’s music affects children’s reading

Investigating how Mozart's K.488 impacts children's anxiety and reading comprehension is the goal of the study on how Mozart's music influences children's reading [11]. 66 senior-grade children from an elementary school (37 males and 29 girls) participated in the experiment. 37 males and 29 females among 66 senior-year elementary school students in southern Taiwan were asked to take part in a learning activity for this study. There were 62 legitimate sets of experimental data that were gathered and examined after individuals who did not finish the full process were eliminated.
According to the protocol, learning anxiety and cognitive load were situational factors of the study subjects, and since these two variables were associated and could not be assessed in advance of the experiment, they were used as situational variables in the study. This study examined the effects of Mozart's K.488 on reading comprehension

and learning anxiety using a quasi-experimental approach with the same number of individuals receiving each experimental manipulation. The investigators adopted the following strategies to lessen the impact of correlation effects: using texts and tests of the same difficulty to avoid the practice effect and cutting the experimental time interval to one week to reduce the aging effect. However, the use of the same group of subjects in the experimental activities may cause some bias in the results due to practice and aging effects. The learning assignment that Mozart's music served as the background music was known as the "music task," while the learning task that lacked music was known as the "silent task." The results showed that it was discovered that students' direct process performance on the music assignment was superior to their performance on the silent reading test.

A recent study found that students who participated in a music assignment performed better in the direct process than those who did a quiet reading activity. The direct process uses fewer attention resources than the interpretation process, which involves higher-level thinking like interpretative integration and comparison evaluation. The direct process consists of routine activities like inference analysis and information extraction [12]. Children in elementary school may experience less fear and perform better when engaged in a direct process when listening to Mozart.

3.5 The impact on music understanding

When children listen to and enjoy music, it can cultivate their musical understanding, which refers to helping them understand the means and forms used in music to address their thoughts and emotions, such as clapping the rhythm, the beat, the speed, enjoying the melody, or the timbre. When children have an excellent ability to perceive musical works, their ability to understand the means of musical expression is more vital. Only when children understand the music and the expression in the music, they will have a deeper and more comprehensive understanding of musical works. Music can also develop children's expressive and physical coordination abilities and creativity; this can be done by letting the children grab an instrument and perform with it while copying the simple rhythm in the music or by letting the children improvise some words.

3.6 Music training improves verbal memory

There is research showing that individuals who took music lessons before turning 12 have better memories than those who did not [13]. Individuals who took music lessons before turning 12 also performed better in the trial. Children may therefore benefit from verbal memory over the long run. The experiment demonstrated that music helped improve kids' verbal memory [13]. The participants were 60 female college students, 30 of whom had taken music lessons for at least six years before the age of twelve, while the remaining 30 had never taken lessons. These participants' verbal memory was tested by having them recollect a series of learning activities, each of which had been verbally explained three times with a list of 16 words. After each presentation, the subject was required to use as many words as possible. The findings indicate that those who took music lessons knew more terms than those who did not. Although there have been some advancements for kids, there have been few for adults. First of all, teaching kids to play an instrument is simpler. Second, practicing music is a form of memory practice that calls on language abilities.

3.7 How music affects prosocial behavior

The purpose of the research on the relationship between music and prosocial behavior was to determine whether a brief music program appeared to enhance prosocial behaviors (such as sharing and making a difference) and official work skills (such as working memory, inhibition control, and cognitive flexibility) in kindergarten students attending two open schools in California [14].

The strategy involved gathering 103 kids between the ages of four and six from two public schools in a city in the United States that had four kindergarten classrooms and two transitional kindergarten classrooms [14]. The experimental group is the other of the two groups, with the first being the control group. The control group participated in group activities such as reading, arts and crafts coloring, and some small group projects with assistance from other kindergarten teachers; they also got five weeks of training. The experimental group received music lessons for five weeks. Each youngster was tested in a quiet room at the participating schools. The youngster was welcomed inside the analyst's classroom, and the two of them then made their way together to the testing area. The prosocial diversion and the two formal job tasks were tested during testing sessions, which lasted 15 minutes. None of the kids objected to engaging in prosocial activities or running errands for the school.

The findings demonstrate that a 5-week music program significantly improved children's cognitive flexibility but not their working memory or prosocial skills (sharing and affecting change). Since children were not retested following the post-test as in other studies, it is unclear if the effects we discovered on cognitive adaptability were sustained [14].

4 Conclusion

In conclusion, this study aims to explore whether music affects cognitive abilities. And some other abilities, including IQ, logical-mathematical abilities, executive function, prosocial behavior, verbal memory, and how Mozart's music affects children's reading. The experiments showed that music can affect different abilities most of the time. For example, IQ can be tested by using the full-scale IQ test. Logical-mathematical ability can be tested using the Suzuki and Rolland methods. Executive function can be tested by using the go/no-go test and the WPPSI-III test. In addition, the

purpose of this paper is to demonstrate to parents the value of music as a subject. Music education can enhance other abilities and skills. However, some Chinese parents view music training as unproductive and may prioritize additional lessons in mandatory subjects instead.

The participants in most of the articles are younger children in primary school and older children in kindergarten, so the age range is limited. In the future, maybe gather children from different age groups and do the experiments because children are defined as people under 14. So, for example, when gathering the participants. Pick students at different grade levels, such as students from grade one or students from grade six. Also, for the investigation of testing the IQ, the scale of measuring it is too many, so giving a general term for these scales would be better.

Music is unlike compulsory subjects, such as math and English, for primary school students. Most schools teach a wide range of topics to children, and schools have done this is to let the students explore different subjects and find some subjects that they like and continue to study it later in secondary school and high school. So, music in primary school is very relaxing because music in primary school is often making music together by singing or playing instruments together, and the music theories in primary schools are not taught much. Although learning music in primary schools sounds unimportant but it can improve many other abilities. Hence, music is very beneficial to either learning in school or as an extracurricular activity.

References

1. Gilbert, S. J., & Burgess, P. W. Current biology, **18**(3), R110-R114, (2008).
2. Moreno, S., Bialystok, E., Barac, R., Schellenberg, E. G., Cepeda, N. J., & Chau, T. **22**(11), 1425-1433, (2011).
3. Wechsler, D. WAIS-III: test de inteligencia para adultos de Wechsler, (2002).
4. Patel, A. D. The Oxford handbook of music psychology, 208-216, (2009).
5. Schellenberg, E. G.In I. Peretz & R. Zatorre (Eds.), *The cognitive neuroscience of music (pp. 430 – 448)*. Oxford University Press. (2003).
6. Heaton, P., Hermelin, B., & Pring, L. Music perception, **15**(3), 291-305, (1998).
7. Geoghegan, N., & Mitchelmore, M. Possible Effects of Early Childhood Music on Mathematical Achievement. (1996).
8. Rosenthal, R., Cooper, H., & Hedges, L. The handbook of research synthesis, **621**(2), 231-244. (1994).
9. Suzuki, S. Nurtured by Love: A New Approach to Education. Exposition Press. (1969).
10. Rolland, P., & Mutschler, M. The teaching of action in string playing: Developmental. and remedial techniques [for] violin and viola (Vol. 1). Illinois String Research Associates. (1974).
11. Su, Y. N., Kao, C. C., Hsu, C. C., Pan, L. C., Cheng, S. C., & Huang, Y. M. **20**(2), 101-112. (2017).
12. L.Y, C. Wikipedia. (2023, April 26) https://zh.wikipedia.org/zh-tw/%E8%AA%8D%E7%9F%A5%E5%BF%83%E7%90%86%E5%AD%B8
13. Chan, A. S., Ho, Y. C., & Cheung, M. C. Nature, **396**(6707), 128-128. (1998).
14. Shen, Y., Lin, Y., Liu, S., Fang, L., & Liu, G. **10**, 1910. (2019).