

Effects of Music on the Spatial Reasoning Skills of Grade-One Pupils

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Abstract. The study determined the significant effect of different types of music on the spatial reasoning skills of children aging from 6-8 years old. Twenty-one (21) grade one students (13 males, 8 females) of Colegio de San Juan de Letran were selected to complete jigsaw puzzle to assess their spatial reasoning skills while exposed to two different conditions: Instrumental Music (Binaural Beats) and Nursery Rhymes (Old McDonald's), respectively. The results were all calculated using Wilcoxon's Matched-Pairs Signed Rank Test. Findings imply that nursery rhymes stimulate the brain's processing of organizing images more effectively than that of instrumental music. Children ranging from 6-8 years old are more likely to perform better on a spatial reasoning task when they are listening to fast-beat nursery rhymes than that of instrumental music; thereby enhancing their spatial reasoning skills. Limitations and suggestions for further studies were discussed.

Keywords: spatial reasoning, music; jigsaw puzzle; grade-one children

Introduction

In Erik Erikson's Theory of Psychosocial Development, it is said that the earliest stages of learning for young children are the most important. The fundamentals of learning are instilled into a child at a very young age and how much importance is placed on these fundamentals can have dramatic effects on the future of the child's learning (Olson, 1996). Specifically, during the industry versus inferiority stage, children ages 6-11 are now capable of performing increasingly complex tasks. As a result, they will now be striving to master new skills (McLeod, 2013). They are now at the stage where they will be learning to

read and write, solve mathematical equations, and make things on their own. Teachers will begin to take an important role in the child's life as they teach the child specific skills, such as their spatial reasoning skills. Spatial reasoning develops naturally since childhood. It is regarded as one of the most basic reasoning abilities, along with verbal reasoning, logical reasoning and numerical reasoning. Being able to reason spatially means having the ability to visualize spatial patterns and mentally manipulating them. It also allows understanding and remembering spatial relations among objects (Hergenhann & Olson, 2007). Some studies suggest that music aids in enhancing one's spatial reasoning (Kulp, 1999; Kurdek & Sinclair, 2001; Mazzocco & Myer, 2003 as cited in Lachance, and Mazzocco, 2006). It is said that music can often be associated with pictures or words with the use of a mnemonic system (Chaplin, 1985). Therefore, this article seeks to find out if music has a direct and significant effect on one's spatial reasoning. It is also interesting to uncover whether a certain genre of music, particularly instrumental music and nursery rhymes, can help enhance the spatial reasoning of grade one pupils.

Context of current researches

Music has been present in all cultures and throughout history. It is an intricate component in life that can influence an individual's ability to perform a certain task, whether positively or negatively (Olson, 1996). Music, when applied in a constructive way, can have positive effects on a child's learning and help them in many ways. One of its main features is its ability to generate a spectrum of emotions in listeners (El Haj, Postal, & Allain, 2012; Hallam, 2008). It can also promote a more positive mood, giving the person a sense of motivation that can further help the individual solve a given task.

Music has also been proven to increase the intelligence quotient of children when engaging in practical music making (Hallam, 2008; Jenkins, 2001; Kokotsaki & Hallam, 2011). Scientists have discovered that music can modify the brain at both functional and structural levels (Hallam, 2008; Schellenberg, 2004). Such neural changes can impact several domains, and that includes one's creativity (Hallam, 2008; Kokotsaki & Hallam, 2011). It has the possibility to induce their creative juices flowing to perform tasks. To most artists, listening to music can help them achieve a certain creativity or ingenuity that they would not be able to do simply on their own (Kokotsaki & Hallam, 2011).

With that, it can be said that music can really affect a person's task performance. In fact, some studies have come to the conclusion that music, especially classical, aids in the storage and recall of information in our memory (Berz, 1995). This may be due to the fact that music can reduce stress, making it easier for people to study and remember information (El Haj, Postal, & Allain, 2012). It can change moods and give more motivation to the listener. A study by Jenkins (2001) found that subjects who listened to Mozart's "Sonata for Two Pianos" showed better spatial reasoning skills than subjects who had not. Specifically, the subjects also showed a short-term improvement in their IQ scores by eight to nine points. This effect is known as the Mozart Effect, and the idea is that the

complex nature of Mozart's music stimulates an area of the brain that processes images and so helps it to process more accurately (Jenkins, 2001).

An eight month study was conducted by Frances H. Rauscher of the University of California at Irvine, in which 19 preschoolers, ranging in age from three to five, received weekly keyboard and daily singing lessons while another 15 preschoolers received no musical training at all (Bower, 1994). At the start, middle and end of the study, the subjects were tested on five spatial reasoning tasks. Spatial tasks are those that require the brain to organize objects within a certain space, like puzzles (Hammond, 2013). After only 4 months, scores on the test to assemble a puzzle to form a picture improved dramatically for the group with the musical training, while the control group didn't, even though both groups started out with the same scores (Bower, 1994). It can be understood that this kind of improvement may not be substantial enough to alter the way people are fundamentally taught, but its results cannot be ignored. Implementing musical training to enhance the young child's learning could have great effects on their spatial reasoning skills. With its resulting improvements in spatial reasoning, music can also be a very helpful tool that can be implemented in their basic curriculum.

On the contrary, some studies concerning the effectiveness of background music on task performance have yielded inconsistent findings. Music has been proven as a distracter on task performance at times (Alley and Greene, 2008; Furnham and Bradley, 1997; Pring and Walker, 1994). Because our senses are so immersed in the music, most if not all, focus on the music; thus, causing distraction to the task at hand. A study by Hjortsberg (2009) found that students performed better on a memory game without listening to any music rather than listening to classical music. Additionally, a study by (Fogelson (1973) as cited in Hallam et al, 2002, found that students who took a reading comprehension test while listening to music became distracted and therefore retained less detailed information.

Meanwhile, Thompson, Schellenberg, and Letnic (2012) also found incongruence on the effectivity of music on task performance. Their study has proven the neural effect of music on reading comprehension. Scores yielded from this task cannot be accounted for by either slow or soft classical music. On the other hand, significant disturbances on reading comprehension has been noted when the music is fast and loud. Interference effects are dependent on the structural characteristics of the music. In 2010 a larger meta-analysis of a greater number of studies states that other kinds of music worked just as well as classical music (Pietschnig, Voracek, & Formann, 2010).

One study found that listening to Schubert was just as good as Mozart, and so was hearing a passage read out aloud from a Stephen King novel (Nantais & Schellenberg, 1999). But only if it is for the purpose of enjoyment, rather than the exact notes being heard (Nantais & Schellenberg, 1999; Pernham & Vizard, 2011). It is found that highly familiar music may also be efficiently processed and less distracting than unpredictable music. Preferred music was rated as significantly

more pleasant than all the other sound conditions and quiet music was rated more significantly more pleasant than the steady-and changing-state speech sounds as well as the disliked music condition (Nantais & Schellenberg, 1999; Pernham & Vizard, 2011). But according to Alley and Greene (2008), familiarity with song lyrics had little effect on performance.

Nursery rhyme is defined to be a short, rhymed poem or tale for children. It may also be considered to be one of the most important foundation of a child's development. The rhymes stimulate the social, emotional, physical, intellectual and musical development of each different ways that they may not be able to realize. For the cognitive development, nursery rhymes aid in the development of a child's skills to memorize, to sequence and to hear, speak move to, and answer patterns. Patterning is the foundation for reading and math skills. Rhymes, on the other hand, assist children to learn and memorize the alphabet and numbers (Kenney, 2005).

Instrumental music is a kind of music that is played by a musical instrument or groups of instruments. A study conducted by Salame and Baddeley (1989) shows that speech is more disturbing than the instrumental music. An auditory phenomenon that has been suggested to modify the physiological and cognitive process together with vigilance and brainwave entertainment, known as binaural beats, is an example of an instrumental music (Goodin, et al., 2012).

In this paper, Grade one pupils are used as the subjects. As stated, spatial-reasoning, or puzzle-solving skill, is an important foundation of learning during the early years of development. It is therefore noteworthy to test the effectiveness of music on the spatial-reasoning of children so that it can be considered as part of teaching strategies in this educational level.

Research Objective

This study aims to determine the significant effect of instrumental music (binaural beat) and nursery rhyme (Old McDonald), on the spatial reasoning skills of grade one pupils, whose age ranges from 6-8 years old.

Hypothesis

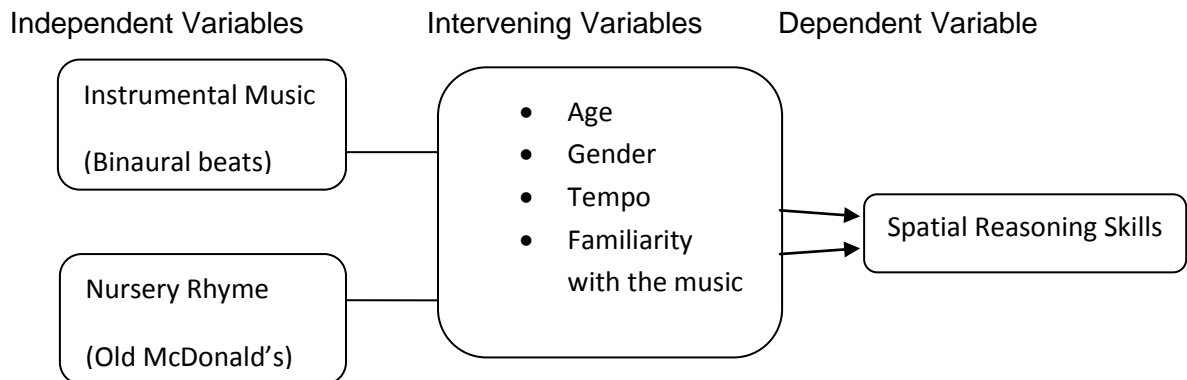
The following hypotheses were tested to achieve the research objective:

Ho: Music has no significant effect on the spatial reasoning skills of grade one pupils

Ha1: Instrumental music (Binaural Beats) significantly increases the spatial reasoning skills of grade 1 pupils better than nursery rhyme (old McDonald)

Ha2: Nursery rhyme (Old McDonald) significantly increases the spatial reasoning skills of grade 1 pupils better than Instrumental music (Binaural Beats)

Research Simulacrum



Methods

A. Procedures

The participants have been recruited through random sampling. Originally, IQ classification shall be used as a part of the research parameters. However, only few subjects were permitted by their parents to join. On the day of the experiment, the researchers first introduced themselves to the participants to ensure a good level of rapport. The two advisers of each section were there to help the researchers in guiding and supervising the participants. The researchers explained briefly to the participants all the necessary information they need to know about the experiment.

After the instructions were given, the experiment proper began. The experiment was divided into two sessions. During the first session, participants were exposed to instrumental music; while on the second session, they were exposed to nursery rhymes. For both sessions, they were tasked to complete forty-two (42) pieces of jigsaw puzzle, with different designs, respectively. The assigned music was played all throughout the experiment. Their spatial reasoning skills were measured through the time they have spent in completing the task. Time in seconds was recorded and compared using statistical treatment.

B. Research Design

In this particular study, the researchers used a within-participants post-test only design, because having the same participants take part in both conditions allowed the researchers to control for many inter-individual confounding variables. The small sample size was also considered.

C. Participants

The participants in the study were twenty-one (21) grade one pupils of Colegio de San Juan de Letran – Manila. There are eight (8) females and thirteen (13) males, whose age ranges from 6-8 years old with the mean age of 6.2381.

D. Sampling Procedures

Random chosen populations were given parental consent forms before they had undergone the experiment because of their age. From the total of 39 students, only twenty-one (21) were permitted by their parents/guardians to join.

E. Measures

In order to assess the spatial reasoning skills of the participants, jigsaw puzzles were used and the time in seconds of its completion was recorded. Jigsaw puzzle is a kind of puzzle that requires the assembly of tiles or interlocking pieces in such a manner as to form the desired picture or a three-dimensional structure. Each puzzle that was used in the experiment has the same level of difficulty. Scores depend on the speed of task completion using time in seconds.

There have not been much any experimental studies testing the effects of jigsaw puzzles on the development of spatial skills of children. Yet it seems pretty clear that puzzle-solving ability and spatial intelligence are linked. According to Levine, et., al (2012), the more frequently young children worked on puzzles before the age of 4, the better they performed on a test of mental transformations of 2-dimensional shapes when they were 4 and a half.

F. Data Analysis

Since they were exposed to two sets of treatments, the researchers used Wilcoxon Matched-Pairs Signed Rank Test to determine the significance of music in the spatial reasoning skills of the participants. The Wilcoxon test for paired samples is the non-parametric equivalent of the paired samples t-test. It is used because the sample data are not normally distributed, and cannot be transformed to a normal distribution by means of a logarithmic transformation.

Results

Table 1

Hypothesis Testing

Variables	P-value	Decision	Conclusion
Music & Spatial Reasoning Skills	0.002	Reject Ho	Nursery rhyme has a significant effect in spatial reasoning skills of grade 1 pupils.

The variables that are used in the experiment are two kinds of music namely, the nursery rhyme (Old McDonald) and instrumental music (binaural beats). The result of the experiment shows that p-value is 0.002, which is less than the given p-value at 0.5 level of significance of p-value (0.002). This means that nursery rhyme is better than the binaural beats when grade one pupils are performing spatial reasoning task. The Binaural Beats takes more time in solving the given task as for the Old McDonald. This means that the grade 1 pupils take more time in solving the puzzle with the Binaural beats as their background music, which

is less than the result of the nursery rhyme, Old McDonald's. This implies that music with fast beats lyrics like Old McDonald's tends to help one to work faster than instrumental music like Binaural beats. On the other hand, Binaural beats help increase one's concentration and attention on the task at hand.

Discussions

The present study aims to determine the significant effect of different types of music, particularly instrumental music (Binaural Beats) and nursery rhyme (Old McDonalds), on the spatial reasoning skills of grade 1 pupils aging from 6-8 years old of Colegio de San Juan de Letran. Based on the results shown earlier, it can be said that nursery rhymes do stimulate the brain in processing images more accurately than that of the binaural beats. Children ranging from 6-8 years old are more likely to perform better on a spatial reasoning task if they are listening to fast-paced and familiar music (nursery rhymes), than that of the unfamiliar and slow-paced instrumental music (binaural beats). Those findings are congruent on the study of Fraser and Bradford (2013), in which their study reported that faster tempos increase the frequency of distractions to the task at hand.

On the contrary, it is also possible that instrumental (or classical) music can also improve one's cognitive function, because according to the study of Jenkins (2001), participants who listened to Mozart's "Sonata for Two Pianos" had shown better spatial reasoning skills than those who had not. Specifically, the subjects also showed a short-term improvement in their IQ scores by eight to nine points (Jenkins, 2001). This effect is known as the Mozart Effect, and the idea is that the complex nature of Mozart's music stimulates an area of the brain that processes images and so helps it to process more accurately.

Other than that, familiarity with the song can also affect the person's spatial reasoning. It is because nursery rhymes are more familiar to them, that it has the tendency to be more efficiently processed and less distracting than the unfamiliar one (Nantais & Schellenberg, 1999; Pernham & Vizard, 2011). When hearing a piece of music that is liked, there is a tendency for their arousal to be raised and their performance to be increased, compared to when they are listening to a piece of music that they liked less. In the study, participants were obviously familiar with the nursery rhyme given to them, as they were they were singing along with the song while performing the task at hand. Thus, they were able to finish the task faster. On the other hand, instrumental music had not significantly improved their speed in completing the task. Nevertheless, it enhanced their concentration.

The current result of the study contradicts with that of Alley and Greene (2008), in their examination of the effects of vocal music, equivalent instrumental music and irrelevant speech on one's working memory, to be able to know the aspects of music that affects the performance and the degree of impairment. They have concluded that the performance on working memory is better when vocal music is used compared to that of instrumental music; however, either silence or irrelevant speech does not significantly affect performance on working memory.

The present study negates their conclusion because the result shows that vocal music with fast beats increases the participants' speed in accomplishing the task at hand than that with instrumental music. Isen, Daubman, & Nowicki (1987), state that positive mood states or elevated levels of arousal created by the music could also have facilitated the participants' performance on the spatial-reasoning task. Alternatively, negative moods or decreased levels of arousal caused by listening to minimalist and repetitive music such as binaural beats may have a detrimental effect (Nantais & Schellenberg, 1999), or both of these factors may have been operative.

Minimalist and repetitive music such as binaural beats might induce boredom or low levels of arousal to the children. Negative emotions such as boredom may decrease the efficiency of information processing relative to positive affective states, causing decrements in learning and performance. (Boyle, 1983; Husain, Thompson, & Schellenberg, 2002; Nantais & Schellenberg, 1999). Meanwhile, exposure to fast-beat and happy music such as nursery rhymes can elevate the person's engagement towards the task (Husain, Thompson, & Schellenberg, 2002; Nantais & Schellenberg, 1999). High level of arousal are often associated with high performance on a variety of perceptual, cognitive, and motor tasks (O'Hanlon, 1981). According to the study of Mayfield and Moss (1989), it is found out that college students who are exposed in any kind of popular music had the highest performance on class problems than those students who are not exposed in any kind of music. Thus, this shows that playing music while working can reduce boredom, frustrations, fatigue, errors and turnovers having a result of a positive performance at the workplace.

Apparently, this experiment shows that music has a significant effect on the spatial reasoning skills of grade 1 pupils. Playing nursery rhymes (Old McDonald) had significantly increased the speed of the participants in completing the puzzle with the average time of 1168.76 seconds, compared to instrumental music (binaural beats) with the average score of 1495.71 seconds. Decrease in time means greater accomplishment. Nevertheless, instrumental music (binaural beats) as background music was observed to have increased the level of concentration of the participants. However, observation also suggests that they have manifested signs of boredom. Seemingly, these observed conditions account for the increase in the amount of time that the participants allotted in completing the puzzle. Meanwhile, nursery rhyme (Old McDonald) as background music appeared to decrease the time in completing the task since the song has a fast beat. Familiarity with the song may also have played a role in accomplishing the task more quickly.

Although the research has reached its aims, there were some unavoidable limitations. First, this research was conducted only on a small size of population of grade 1 pupils in the Colegio. Second, the timeframe given in conducting the study is very minimal; hence, speed in completing the task was the only measure employed to test the improvement of spatial reasoning skills while under the given conditions. Lastly, the setting of the activity was manipulated. The tables were arranged to decrease the participants' chances of cheating and to

avoid the disorderly layout of the pieces of puzzle. But the effects of such condition to the variables at hand were not accounted in this study.

For additional findings, it is highly recommended to use other kind of spatial reasoning materials like Lego blocks, rubrics cube or other similar tools that can hone participants' spatial reasoning skills. Other genre of music may also be considered to test the validity of the current findings to similar participants or to a more advanced age-group with higher academic level. It may also be advantageous to include the interplay of cognitive level, such as Intelligence Quotient (IQ) and spatial reasoning skills in examining the effectiveness of music on task performance. Other measure of performance, such as quality of spatial organization, can be used to assess improvement of spatial reasoning skills.

Conclusions

Music has been proven as an effective intervention in enhancing higher-level of cognitive functioning across all ages. The present study tested its effectiveness on improving spatial reasoning skills of Grade one pupils. Results of the study strengthened previous findings. Music has an effect on enhancement of spatial reasoning skills. Between the two types of music employed in this study, fast beat music, such as nursery rhymes is proven to have more significance in enhancing the spatial reasoning skills of the participants. The familiarity of its lyrics and its lively tempo apparently increased speed and accuracy in performing the spatial task at hand.

Contrarily, instrumental music, such as binaural beats, has lesser significance on improving spatial reasoning skills. Seemingly, its uncommon beat and its absence of lyrics decreased the participants' speed in completing the task. The recorded average time of puzzle completion in seconds proves the claim. Nursery rhymes as background music allowed the participants to complete the puzzle at 1168.76 seconds, while instrumental music (binaural beats) made them finish at 1495.71 seconds, on the average. Despite its disadvantage on improving the speed for completion, instrumental music (binaural beats) increased task-concentration and attention, as observed.

Overall, both conditions are seen as effective interventions in augmenting spatial reasoning skills of children whose age ranges from 6-8 years old. As quantified, speed in spatial task completion is improved. In addition, greater concentration, and attention to spatial task is observed. These factors are essential in mentally manipulating and organizing details in the environment. Children at this age range are expected to develop them in order to master their specific cognitive developmental task and to prepare them for other forms of higher mental functioning. Henceforth, educators in this academic level should consider the use of both interventions as part of their teaching and learning strategies.

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