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The influence of music on the cognitive development of primary school children

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***Abstract*---**In the present day, the most common issue that parents and teachers face with children is poor attention and memory, which lead to poor academic performance. To ensure healthy cognitive development with primary focus on attention and working memory, we need genuine techniques crafted with passion and precision to help children learn and develop. The Indian education system mainly tests memory of students. Techniques that improve attention and working memory would enable children to perform better in examinations and in turn improve their self-esteem and overall well-being. Research shows that music training improves attention and working memory. This paper examines the literature on the effect of music training on attention and working memory and suggests that it plays a vital role in improving attention and consequently working memory. In this paper, the researcher has provided a detailed analysis of the specific areas of attention and working memory that need to be sharpened, with structured activities to enhance each area during learning sessions in order to accelerate academic progress. In this paper, the researcher has created a conceptual framework based on the detailed review and a structured musical activities table to enhance attention and working memory of primary school children. The findings of this review paper can be applied by curriculum designers and educators.

***Keywords*---**attention, working memory, music training, cognitive development.

Introduction

We live in an era where the level of competition in the field of education is extremely high. This leads to added stress for parents and students, when it comes to performance in examinations. In the Indian education system,

performance in examinations mainly assess the level of training and memory of students. Memory is one of the most important cognitive functions that not only aids in high performance in exams but also improves daily life functioning and organizational skills of individuals. According to Sternberg (1999), Memory is the means by which we draw on our past experiences in order to use this information in the present. According the Schachter (1999,2000), Memory is the term given to the structures and processes involved in the encoding, storage and retrieval of information. In the present day, the most common issue that parents and teachers face with children is their inability to focus completely during class activities, which in turn leads to poor performance. The most important factors influencing concentration in class activities and effective learning, are attention and working memory. The structure of everyday classwork requires students to actively focus, understand and perform the assigned cognitive tasks.

According to William James (1890), Attention typically refers to selectivity of processing. (Eysenck & Keane, 2005). According to Baddeley & Hitch (1974) and Baddeley (1986) Working memory, is a system that temporarily holds information as people perform cognitive tasks. Working memory is a mental workspace on which information is manipulated and assembled to help individuals comprehend language, make decisions, and solve problems.Thus, it's clear that these two cognitive activities are highly essential for everyday learning of students.

The Impact of Music On A Child's Overall Wellbeing

Apart from focusing on academic progress, children should also enjoy the learning sessions planned for them. Thus, it's important to incorporate creative modes in their sessions like art, music and dance to enable effective and enjoyable learning. Life, in today's world is fast paced, filled with easy access for instant gratification and highly competitive, irrespective of the age group. It's a digital era where there's no dearth of options for excitement and high levels of stress. Music has always been, is and will continue to be a great mode of entertainment and therapy. Its multidisciplinary application value has been instrumental in creating its universal impact. (Raymond, A.R. & Macdonald., 2013) studied the impact of music education, everyday uses of music, music medicine, music therapy, everyday music listening and community music on well-being. The findings of the study indicated that all well-being related music interventions are fields of practice and research that have major contributions in positively influencing key aspects of health.

The Importance of Music Training during Primary School Education

Each parent and each household have a different nurturing style and a different teaching pattern. Based on genetics, environmental aspects and various other factors, each child begins to learn and develop cognitively. Thus, every child's learning curve is so unique and different. During playschool and kindergarten, in spite of having learning differences, children tend to sail through as during this stage most of the learning takes place through play and fun modes. It is during Primary school (from standard 1) that school becomes structured, traditional learning based and full day school begins, in the Indian context. Due to all these aspects, teachers begin to grade students based on their performance in

examinations and they are categorized as top scorers or the brilliant ones, the above-average students, the average students and the poor performers.

The parents of the poor performers are then given feedback about their children's academic performance and this in turn puts them under a lot of distress. Many a time, poor performance of the children is due to poor attention and working memory. A child with poor attention and working memory will perform poorly during examinations and on an IQ test due to inability to focus on the tasks at hand. Thus, structured interventions made to sharpen the attention and working memory functioning of students would benefit them in various aspects like concentration, efficient task performance and effective task completion. These are extremely important aspects that would in turn positively influence cognitive development and improve academic performance.

Primary school children specifically belonging to the concrete operational stage are able to deal systematically with the complexities of representations and can understand the logic of concrete objects and events, as described by Piaget (1970). Thus, they require effective strategies to enhance overall and holistic development, which will in turn improve their life in general. In this context, Dumont, E. et.al (2017) reviewed the latest evidence on the effect of musical interventions on the development of primary-school aged children. All empirical studies were reviewed and involved participants between 4 and 13 years of age. The reviews analyzed the evidence of 46 studies, dealing with five developmental domains, including motor, social, cognitive, language and academic domain. A definitive positive impact of music interventions was observed on specific motor skills, partial impact on emotional development, related to empathy and prosocial behavior and a positive impact on cognitive functioning, especially on working memory.

The Relationship Between Attention and Classroom Learning

According to William James (1890), Attention typically refers to selectivity of processing. (Eysenck & Keane, 2005). On a single day in our lives, we encounter several stimuli, many of which we might not even perceive. Our experiences and preferences make us respond to only selected stimuli. We respond only to what we observe and we observe only what catches the eye and appeals to us. Before beginning any class, the teacher can introduce an auditory stimulus related to the topic. This would build the attention of students.

Active and Passive Attention

William James (1890) distinguished between active and passive attention. He explained that attention is active when processed in a top-down manner, focusing mainly on the individual's goals and expectations. He further explained that Attention is passive when it is processed in a bottom-up manner, when the focus is mainly on external stimuli. During the concrete operational stage, children mainly focus on external stimuli and gradually build them up to construct the concepts in their minds. They need a lot of demonstrative teaching and live examples to gradually develop Active attention. (Eysenck & Keane, 2005) As it is

clear that primary school children mainly focus on external stimuli, visually stimulating props can be used in every class to ensure attention.

Focused Attention and Divided Attention

According to Michael W Eysenck and Mark T Keane (2005), Focused Attention or selective attention is the concept studied when people are exposed to two or more simultaneously presented stimuli and are instructed to respond only to one. This type of attentions helps us understand the selection process and the unattended stimuli. During the class in school, we observe that there are few students who are able to focus on the teacher's instructions irrespective of the distractions and other interfering stimuli, whereas there are other students who are not able to focus on the class and get distracted easily. Thus, to sustain focus, teachers can use relatable activities while teaching challenging concepts. This can include listening to songs related to the topic.

Divided Attention, on the other hand is the concept that is studied when people are exposed to at least two simultaneously presented stimuli and are instructed to respond to both or all stimuli. This type of attention studied will help us understand processing limitations and gauge the attentional capacity of an individual. Many a time during class, students are required to listen to the lecture, take part in activities and write down notes, with their attention fixed on all three aspects, without getting confused. But this seldom happens as most students get confused with multiple instructions and end up not doing any of the three required tasks. Thus, they need effective strategies aimed at sharpening their divided attention skills. To sharpen this skill, teachers and parents can use activities like coloring a picture while listening to a story and reciting it.

Change Blindness

There are multiple situations where in we initially miss observing a friend who just got a haircut, someone's new clothes or different accessories and we keep wondering how we missed observing such conspicuous changes when they are brought to our attention. According to Michael W Eysenck and Mark T Keane (2005), Change blindness occurs when changes in an object are not perceived, when that particular object was not previously the focus of attention. This concept of change blindness clearly indicates that attention and perception are closely related. (Eysenck & Keane, 2005). Making the children spot the differences in two almost similar settings or pictures will sharpen this skill.

Focused Auditory Attention

According to British scientist Colin Cherry (1953), the cocktail party effect refers to the attentional capacity of an individual to focus on one particular conversation, during a party when several simultaneous conversations are taking place. He explained that this ability to maintain attention to a chosen auditory message, involves using physical differences, for e.g., sex of the speaker, voice intensity, speaker location, etc. (Eysenck & Keane, 2005). Students who are interested in the topic will focus, despite all distractions and thus activities to build interest in the topic should always precede the lectures and note taking.

This can include a documentary played related to the topic, a brainstorming session or debate related to the topic.

According to Deutsch & Deutsch (1967), there is complete perceptual analysis of all stimuli that we sense, and only the important inputs lead to responses. (Eysenck & Keane, 2005). In a class, only topics that interest students, lead to responses and thus understanding the interests of the children will help to structure games for them and group them accordingly. According to (Lavie., 1995,2000), everyone has limited attentional capacity and the amount of attentional capacity allocated to the main task depends on its perceptual load, which in turn is determined by the number of units in the display and the nature of processing required for each unit. She further explained that any spare capacity beyond that taken by the main stimuli is automatically allocated to irrelevant stimuli.

Thus, tasks designed by teachers should take into consideration this aspect of perceptual load, in order to ensure that students remain focused and grasp the concepts without getting distracted by irrelevant stimuli. Tasks should thus be timed appropriately with intermittent breaks to facilitate effective learning. (Eysenck & Keane, 2005)

The Relationship between Working Memory and Classroom Learning

Majority of the activities that we engage in are the ones that we do on a day to day basis, and we are consciously aware of, be it an activity, a game or any short task at hand. According to Baddeley and Hitch (1974) and Baddeley (1986), working memory is a complex system, replacing the concept of short-term store and has four components.

The four components constitute

1. A modality-free central executive resembling attention
2. A phonological loop holding information in a speech-based form.
3. A visuo-spatial sketchpad specialized for spatial and visual coding, and
4. An episodic buffer, which is a temporary storage system that can hold and integrate information from the phonological loop, the visuo-spatial sketchpad, and long-term memory. The control functions are performed by the central executive. (Eysenck & Keane, 2005)

Thus it is evident that all conscious tasks that we perform on a day to day basis, especially the ones performed by students in the course of “in-class activities”, completely rely on the effective functioning of the various parts of working memory.

The Effect of Music Training on Attention and Working Memory

Music interests children and they always enjoy listening to it. The application of music interventions in schools would have many advantages as it would help in relaxation and cognitive development at the same time. (Mylene Barbaroux et. al., 2018) analysed the influence of music training with demos on cognitive functions

in children from low socio-economic backgrounds. The findings of the study indicated that music training, improved concentration, reading precision and overall cognitive development.

Not only children, adults also gain a lot from music in terms of relaxation and cognitive development. (Bahar Yesil & Unal Suheyla, 2017) conducted a study to investigate the effects of music training on attention and working memory in adults. The results of the study showed that long term and regular music training caused improvement in working memory activity. The study findings clearly indicated that regular and intensive music practice had functional effects on cognition in adults. Children show great results from any training due to their grasping speed and adaptable mind.

(Ingo Roden et. al, 2014) analysed in detail, the effects of music training on attention, processing speed and cognitive music abilities among primary school children aged 7 to 8 years . The findings indicated that music training led to increases in both processing speed and visual attention over time. Musical memory is classified into acoustic (auditory) which can be compared to verbal working memory, processed by the phonological loop, muscular memory which can be compared to spatial working memory processed by the visuospatial sketchpad and visual memory, again processed by the visuospatial sketchpad. (Flesch & Martens, 1924) (Eysenck & Keane, 2005). All these areas of musical memory are processed in the same areas as working memory. (Thomas Rammsayer, 2006) (Vanessa Stuming et.al., 2007).

(Mei-Chun Cheung et. al., 2017) carried out an EEG study to investigate how musical training was associated with brain activity during verbal memory encoding phase among musically trained and non-musical individuals. The findings of the study showed that the musically trained group demonstrated better verbal memory than the non-musical group. Findings of the EEG study revealed that musical training led to cortical synchronization of neural networks involved in verbal memory formation.

(Alexandra C. Taylor et. al., 2017) conducted a study to investigate the influence of musical training on verbal memory. The findings indicated that musically trained participants recalled higher number of words and hence had better verbal memory for words presented in all three modalities and had greater cognitive skills in general. (Francesca Talamini et. al., 2016) conducted a study comparing the working memory of musician and non-musicians. The findings of the study indicated that musicians had larger working memory spans than non-musicians regardless of the sensory modality the stimuli were presented in.(Nina Kraus et. al., 2014) conducted a study to identify and compare the effect of musical training on auditory learning in 19 at risk children aged 7-10 years, in a community setting. The results showed that children who received instrumental music training had faster and more robust neural processing of speech, compared to children who were in the music appreciation class.

(Sissela Bergman et. al., 2014) conducted a longitudinal study of child development to analyse the association between musical practice and performance on cognitive abilities such a reasoning, processing speed and

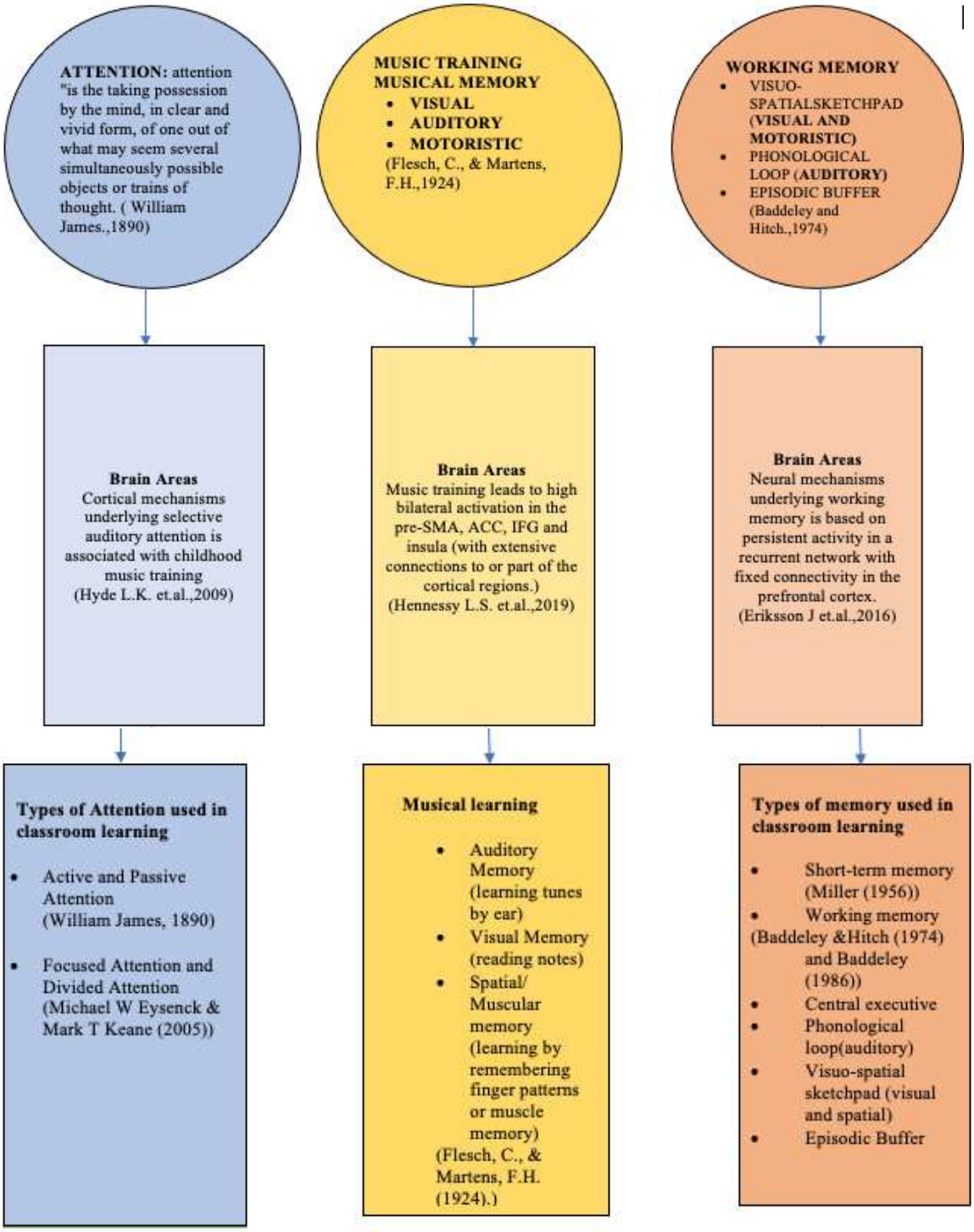
working memory. The findings showed that musical practice had an overall positive association with visuo-spatial working memory capacity and verbal working memory capacity, processing speed and reasoning. The imaging study findings showed that music players had larger Gray matter volume in the temporo-occipital and insular cortex areas.

(Ingo Roden et. al., 2012) conducted a longitudinal study to analyse the effects of school based instrumental music program on verbal and visual memory in primary school children. The results showed that students with musical training exhibited superior verbal memory skills. (Mads Hansen et. al., 2012) conducted a study to understand the effect of musical training on verbal and visuospatial working memory. The findings indicated that as expert musicians outperformed the other groups on the verbal memory tasks, musical training enhances verbal working memory. (Huang Z et. al., 2010) conducted a study to identify and compare the neural correlates of verbal working memory among musicians and non-musicians. The findings of the study indicated that musicians had superior verbal working memory compared to non-musicians.

(Joseph M. Piro, J et. al., 2009) conducted a study to assess the effect of piano lessons on the vocabulary and verbal sequencing skills of primary grade students. The findings of the study indicated that the students who received formal musical education had significantly better vocabulary and higher verbal sequencing scores, in comparison to the students who had no exposure to music lessons. (Frankling S. et. al., 2008) conducted a study to analyse the effect of musical training on verbal memory. The findings of the study indicated that musicians have greater verbal working memory, verbal memory span and long-term memory, compared to non- musicians.

(Lorna S. Jakobsen et. al., 2008) studied the effects of extensive musical training on non-musical cognitive abilities namely verbal and visual memory. The findings of the study showed that musicians exhibited superior immediate and delayed recall of word lists and greater use of semantic clustering strategy during initial list learning, compared to non-musicians. The study findings also showed that musicians had superior learning, delayed recall and delayed recognition for visual designs. The results of the study, thus suggested that music training greatly enhanced auditory and visual memory functions. (Thomas Rammasayer., 2006) conducted a study to examine and compare the levels of temporal processing among musicians and non-musicians. The findings of the study revealed that musicians exhibited superior temporal acuity for auditory fusion, rhythm perception and 3 temporal discrimination tasks, compared to non-musicians.

Fig. 1 showing the relationship between music , attention and working memory



Method

Research Objectives

- To provide a detailed analysis of the conceptual framework of attention in relation to learning and cognition of primary school children
- To provide a detailed analysis of the conceptual framework of working memory in relation to learning and cognition of primary school children.
- To provide a detailed review of the effect of music on attention of primary school children.
- To provide a detailed review of the effect of music on working memory of primary school children.
- To create a musical activities table to enhance attention and working memory of primary school children and propose the implementation of the same in primary schools.
- To create a conceptual framework model connecting music, attention and working memory.

The researcher strongly believes that the implementation of the musical activities table in schools would make learning fun and enjoyable and would also enhance their cognitive development, improving their attention and working memory.

Pilot study

A Pilot study was conducted on 5 girls and 5 boys , studying in 2nd standard, studying in Bright Public School Bangalore, A CBSE unaided School. Participants: 10 second standard students (5 boys and 5 girls) M_{age} =7.5 years, were chosen for the pilot study, using purposive sampling technique. The children belonged to low and middle income families.

Materials

The Musical activity table created by the researcher to improve attention and working memory of primary school children.

Musical Activities Table

Cognitive area	Musical activity	Duration of activity	Materials required	Success of task
Focused Attention	The two box Listening task	30 seconds	Two opaque boxes, raw rice grains and sugar crystals	When the student correctly guesses the rice grain box
Divided Attention	Coloring and listening task	1 minute	Coloring sheet/picture drawn in notebook and a song	When student colors the picture and recalls aspects related to the song
Visual Working Memory	Spot the differences and listening	1 minute	Two pictures almost similar and a song	When the student spots all the differences while listening to the song

	task			
Verbal Working Memory	Create a song task	5 minutes	A topic with multiple points to be remembered	When the student composes a song with the topic headings
Spatial Working Memory	Build an action song	10 minutes	A challenging topic and students in groups of 5	When each group successfully creates an action- song related to the challenging topic

Procedure

The study was done over a span of a month to check the effectiveness of the tasks. On a particular day, students were assigned only one task from the music activity table. During the first task of Focused Attention, two opaque plastic boxes were each filled with the same amount of raw rice grains and sugar crystals each. The students were informed that one box had raw rice and the other has sugar. The researcher shook each box and asked the children to point to the box that had raw rice.

During the second task of divided attention, students were given a picture to color and a song was played during this task. After 1 minute the buzzer rang, marking the time up signal. Students were now assessed based on who completed the picture and few questions related to the song were asked like,

1. Can you hum the tune of the song?
2. Can you recall any two words from the song?
3. What was the song about?

During the third task of Visual Working Memory, The students were given two almost similar pictures to spot the differences , while listening to a song. The timer was set to 1 minute. After this the students were assessed based on who spot all the differences. During the next task of verbal working memory, the students were assigned a topic from their books , with many subheadings to remember. They were asked to compose a song with the given headings and were given 5 minutes for this task. During the last task of Spatial Working Memory, The students were given a Biology related topic, Where parts of the body were involved and were divided into groups of 5. Each group had to build an action song together and perform in front of the class. The duration of this task was 10 minutes (Widana et al., 2020; Widana et al., 2021).

Results of the Pilot study

After all the tasks, a general review was held and the students said that they enjoyed all the tasks and it helped them remember what they learnt for much longer. The teachers said these tasks helped them in sustaining the attention of students for the entire session and led to a positive learning outcome.

Conclusion and Implications

The findings of the paper indicate that attention and working memory are the main cognitive functions being employed during classroom sessions. The review

findings indicate that music has a positive impact on both attention and working memory and can be incorporated in the learning activities of students in an informal manner. Musical activities incorporated into learning sessions make learning fun and effective. The findings of this study can be applied by curriculum designers and educators. The musical activity table can be used by teachers during their sessions and does not require expensive materials or trained professionals for administration. It is very simple and easy to administer without any language or cultural barrier. All the suggested activities are short, fun and effective. Further studies can be carried out using the music activity table as an intervention.

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