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PLAYING AROUND NATURE: EFFECT ON WORKING MEMORY OF PRESCHOOLERS

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Abstract

Title of the Paper: Playing Around Nature: Effect on Working memory of Preschoolers

Objective: The present study aimed at examining the effect of playing and being active within natural environment on working memory of preschoolers.

Subjects: The study was conducted on sixty-four preschoolers (age range: 3-5 years).

Method: Quasi experimental pre-test post-test design was used to assess the effect of engagement of children in activities in natural environment on their working memory.

Result: The result shows the significant positive effect of such active play on preschoolers' working memory.

Conclusion: In conclusion it can be said that physical activity is a great way to enhance the working memory of preschoolers without making them burdened with cognitive training.

Recommendation: Further intervention studies should confirm findings in larger samples, and it would be beneficial to lengthen the intervention duration and to examine the training benefits on other cognitive aspects of the child.

Key words: Physical Activity, Preschoolers, Working memory

INTRODUCTION

The cognitive development that ensues during preschool years is critical to children's future life. Many studies have reported that cognitive aspects assessed in early life were associated with academic achievement (Geary, 2011). Executive functions (EFs) refer to the cognitive processes necessary for goal-directed cognition and behavior (Best, 2011). These serve as an umbrella term to encompass the set of higher-order cognitive abilities that are necessary to peruse and achieve a goal (Cristofori, Zimerman & Grafman, 2019). It consists of the three core skills namely working memory, inhibitory control and cognitive flexibility (Miyake et al., 2000). These skills develop across childhood and adolescence (Koechlin & Summerfield, 2007). Working memory involves both keeping information in mind and manipulating it in some way, such as in passage comprehension. Cognitive flexibility involves thinking about something in multiple ways for example, considering someone else's perspective on a situation. Inhibitory control is the process of deliberately suppressing attention such as ignoring a distraction,

stopping an impulsive utterance, or overcoming a highly learned response (Zelazo, Blair & Willoughby, 2016).

EFs enable us to understand complex concepts, solve problems, planning things, and managing the actions. EFs have also been found to be associated with the frontal lobes (Cristofori, Zimerman & Grafman, 2019). An expanding body of research has shown that executive function develops rapidly during the preschool years, with adult-level performance being achieved during adolescence or later (Moriguchi, Zelazo & Chevalier, 2016). The executive attention majorly develops during early years of life (Rueda, Posner & Rothbart, 2005). Hence preschool period may be the most suitable time when the development of EFs of the child should be aimed.

Physical activity is one of the important factors that may improve cognitive function from childhood to adulthood. The review of the studies shows that higher level of physical activity is related to increased cognitive functions and academic performance (Hillman, Pontifex, Raine, Castelli, Hall, & Kramer, 2009; Davis et al., 2007). However, studies with stronger evidence in case of preschoolers is warranted. Researches indicate that both acute and chronic aerobic exercise promote children's executive function (Davis et al., 2007; Hinkle, Tuckman, & Sampson, 1993 as cited in Best, 2010). The researches indicate that aerobic exercise does not have a limited effect on lower level perceptual or cognitive processes (Morris & Graydon, 1996 as cited in Best, 2010) but instead impacts the complex cognitive abilities that permit humans to behave in an adaptive and goal-directed fashion (Best, 2010).

Physical activity is defined as any bodily movement produced by skeletal muscles that result in energy expenditure (Caspersen, Powell & Christenson, 1985). Ways of being physically active include walking, cycling, playing outside and active recreation. Both moderate and vigorous intensity physical activity improve health (World Health Organization, 2020). Regular physical activity is helpful in preventing diseases like- heart disease, stroke, diabetes, obesity etc. It also helps in preventing hypertension and in maintaining a healthy body and mental health. Engagement in physical activity also improves quality of life. Also, cognitive functions have been shown to be benefited from physical activity. The beneficial effects of exercise on brain function are of widespread interest but remain vague (Chaire et al., 2020). Some of the physiological effects of physical activity include increased levels of brain-derived neurotrophic factor, which in turn could affect neuronal plasticity and cognitive functions (Ferris et al., 2007 as cited in Sjowall, Hertz & Klingberg, 2017). Researches have demonstrated that physical activity has a positive impact on executive attention (Cassilhas et al., 2016; Sousa et al., 2018). Studies have also shown that more physically fit participants performed better during visual figure recognition than less physically fit (Maass et al., 2015). However, almost all the findings mentioned above provides the results regarding effect of physical activity on adolescents or adult population. Exercise studies have been quite inconsistent (Chaire et al., 2020) and the number of studies on the effect of physical exercise on preschool children especially those focusing on physical activity close to nature is very few. Hence, it is essential to continue to study the cognitive benefits of physical activity, particularly in preschoolers.

A cross-sectional study showed a relationship between aerobic fitness and neural rhythms in a visuo-spatial attention task in young adults (Wang et al., 2015). High-fitness participants had faster reaction times according to the findings. These findings also indicated that aerobic fitness could be positively related to visuo-spatial attention capacity. Researchers

have argued that even single bouts of physical exercise may be sufficient to improve memory performance and attentional processes (Roig et al., 2016; Hogan et al., 2013 as cited in Chaire, Becke & Duzel, 2020). But it remains unclear whether these activities improve working memory at early stages of development i.e., at preschool level. Numerous studies have shown a positive association between physical fitness and working memory (Raine et al., 2016; Scudder et al., 2016). However, a number of meta-analyses have shown more vivid picture of this relation pointing out that some of the positive correlations are from cross-sectional studies where there is a risk of confounding variables (Verburgh et al., 2014 ; Cooper et al., 2016; Spruit et al., 2016 as cited in Sjowall, Hertz & Klingberg , 2017). Various forms of physical activity interventions exist that are varied in time, length, intensity and type. There is a need to be specific about what type of intervention will give the best results. Additional information is needed before making policy decisions such as a mandatory increase in physical activity for children in their preschool years. Physical activity can also have beneficial effects on objective measures of stress such as low and high blood pressure, vomiting, dizziness (Janssen & LeBlanc, 2010). Chronic and acute stress can impair cognitive functions, including working memory (Leach & Griffith, 2008; Evans & Schamberg, 2009 as cited in Sjowall, Hertz & Klingberg, 2017).

Therefore, working memory is a viable variable to target in interventions. Working memory is strongly associated with academic achievement (Bull et al., 2008). Deficits in working memory are common in neurodevelopmental disorders such as Attention Deficit Hyperactivity Disorder (Martinussen et al., 2005). Hence, a deficit in working memory should be checked at an early age. Cross-sectional studies of 9–10-year-olds have demonstrated an association between measures of physical fitness and working memory capacity (Raine, Scudder, Saliba, Kramer, Hillman, 2016). Very less is known regarding a probable causal effect where increased PA would lead to improved working memory especially in case of preschoolers. In the present study the effect of physical activity on working memory of preschoolers was studied.

STATEMENT OF THE PROBLEM

Playing Around Nature: Effect on Working memory of Preschoolers

MATERIAL AND METHOD

DESIGN AND PARTICIPANTS

Sixty –four preschoolers (age range: 3-5 years, mean age: 3.81 years) were recruited for the study. The participants were randomly assigned to an experimental and control group each consisting of 32 preschoolers. Fifty-five preschoolers participated till the last phase of the study. Five participants dropped out of the study and four participants were excluded because of health issues. Finally, the experimental group consisted of 26 preschoolers who performed physical activity close to nature. The control group consisted of 29 preschoolers who remained engaged in their daily life activities only**.** A written consent was obtained from the parents of the preschoolers participating in the study. Participants received chocolates, toffees & playing items as reward for their participation in the study. The experiment was carried out in accordance with the guidelines of the Faculty Research Review Committee, Faculty of Education, Dayalbagh Educational Institute, Agra, India.

THE INTERVENTION

Physical Activity Close to nature (Experimental group)

The experimental group was exposed to physical activity close to nature for the period of 12 weeks. The children of this group visited agricultural fields with their parents in the early morning for 2 hours for at least 5 days a week. They were engaged in basic physical activities like running,

walking, jogging, jumping, stretching of hands and legs, cleaning of fields, taking out weeds around plants, collecting weeds at one place and other healthcare exercises.

Engagement with Daily life activities (Control Group)

The control group did not practice any specific activity and remained engaged in regular daily life activities.

OUTCOME MEASURES

Backward Word Span Task (Working Memory Assessment)

Backward word span by Davis and Pratt (1996) was used to measure the working memory capacity of preschoolers. In this task children were shown pictures of familiar objects one at a time (e.g., a ball and bat) and were asked to recall them in a backward order. Children completed two practice trials and then up to nine experimental trials, three of each span length (two, three and four). In case children got at least two out of the three trials correct, the span length was increased. The number of trials correctly recalled in a backward order were considered as dependent variables.

RESULTS

Participant Characteristics

Demographic details of the participants are reported in table 1. As shown in table 1 groups were matched for age and sex. Groups did not differ at baseline for working memory ($t < 1.96$; $p > .05$).

Table 1

Group Demographics at Baseline

Number	26	29
Age	3.73	3.94
Gender (Girls/Boys)	12/14	14/15
Working Memory	4.26	4.17

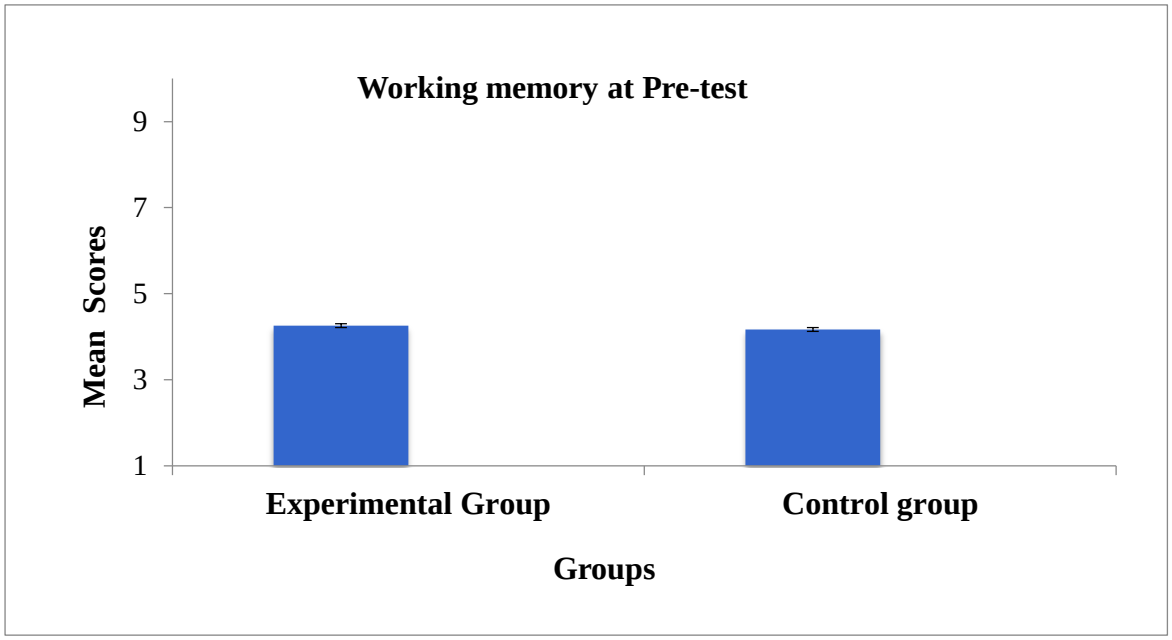

Figure 1| Mean Scores of Working Memory of Experimental and Control Group at Pre-test

Statistical analyses were performed using the statistical software SPSS version 20.0. We ran independent sample t-test to assess whether there exist any differences between the groups at baseline (pre-intervention). There were no differences found between the groups at baseline (table 1, figure 1.) Additionally, to examine the possible effect of training on cognition, the t test was again used to assess the difference between the two groups. The t value was found to be statistically significant at this stage which showed that there exists a significant difference between the two groups (table 2, figure 2).

Table 2

Working Memory Assessments at Post-test

Group	Working memory scores	t- value
EG	6.65	4.96*
CG	4.31	

*Significant at .01 level

The calculated t- value (4.96, $p < 0.01$) of working memory of the two groups reflects that the difference between the groups is significant. Hence, it was found that there is a significant effect of physical activity on working memory of preschoolers.

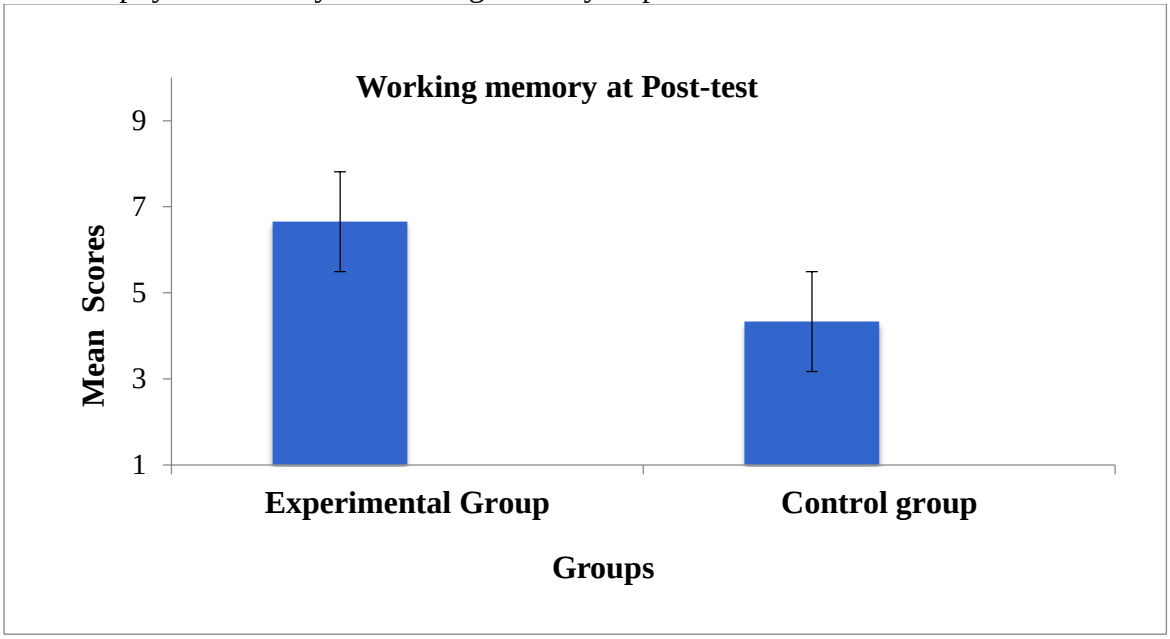

Figure 2| Mean Scores of Working Memory of Experimental and Control Group at Post-test

Additionally, there was significant increase found in the scores of experimental groups from pre-intervention phase to post intervention phase whereas no significant improvement was seen between the scores of controls from pretest to posttest (table 3; figure 3).

Table 3

Working Memory Scores over Repeated Measures

Group	Pre-test	Post-test	t-value
EG	4.26	6.65	4.88*
CG	4.17	4.31	.80

*Significant at .01 level

Figure 3| Comparison of Mean Scores of Control and Experimental Group at Pre- test and Post-test

DISCUSSION AND CONCLUSION

As anticipated the result showed the positive effect of physical exercise on working memory of preschoolers. A significant increment was found in the scores of WM of experimental group from pre to post test phase as a result of intervention of period of 3 months. Only exercise group showed enhanced working memory compared to the control group, as shown by the significant t -value ($t > 2.58$; $p < .01$). In addition, subjective analysis showed that the children of experimental group were reported to be calmer and patience with less aggressive behaviour as reported by their parents and teachers. The present study has some limitations as well. First, we had a limited sample size of 26 subjects comprising the exercise group. Further intervention studies should confirm findings in larger samples, and it would be beneficial to lengthen the intervention duration and to examine the training benefits on other cognitive aspects of the child. Comparison can also be made between different age groups and different types of physical activity.

On the other hand, inactive group was matched in age, sex, and baseline level. Second, we could not measure outside activity; however, we encouraged all participants to avoid changes to their lifestyle for the time of the intervention. The study also has limitation in a sense that we did not measure the children physical characteristics and fitness level prior to intervention. Taken together, our study provides evidence in support of physical activity benefits for preschool children. To conclude it can be said that physical activity is a great way to enhance the working memory of preschoolers without making them burdened with cognitive training. Thus, the parents, teachers and school administration should aim at providing such opportunities wherein the child can remain engaged in more and more physical activity. The preschool curriculum should be designed in a way that it should have more focused on physical activities as per their age

group along with cognitive one. It can help the child to enjoy his /her childhood along with their mental and physical development. The future researches should aim at finding out the ways that combine both the physical and mental training together to train the child.

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