A pilot study examined the impact of a motor-cognitive intervention on the working memory abilities of inspiration children.

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Background: Learning involves several different brain processes, thus disturbances in any one of these systems might cause learning problems. According to reports, the frequency of learning disabilities among school-age children in India ranges from 1% to 19%, depending on the age group, survey method, tool, and geographic area of the nation. When performing a variety of cognitive tasks like comprehension, learning, and reasoning, the working memory is a system for temporarily storing and manipulating information. Children with poor working memory may struggle to pay attention, become easily distracted and perform poorly in academic compared to their classmates. They run the danger of never returning to school and not living up to their full potential. Exercise has been demonstrated to have a favourable impact on cognitive functions like frontal lobes and long-term memory processing. We attempted to determine if motor cognitive intervention such as Brain button, Hook up 1&2, Cross crawl, Thinking caps, Positive points, Lazy eight might particularly influence working memory of children.

Methodology: In first phase of study children aged 8-11 years old from government primary schools of Anand district, Gujarat were screened for risk of developing learning disabilities by IHBAS SLD screening Questionnaire (2007). In second phase children who had risk of developing learning disabilities examined for PGI memory scale and split into experimental and control group. Then after experimental group children made to do motor cognitive interventions for 20 consecutive days. Subsequently, both experimental group and control group children examined for PGI children's memory scale for their memory performance.

Results: Total 100 primary school children surveyed for risk of developing learning disabilities by IHBAS SLD screening Questionnaire (2007). Among all children aggregate 31 children had risk of developing learning disabilities. Majority of the children 48.4% belong to age group of 9-10 years. The mean age of children 9.32±0.85. In all age group in experimental group children, motor cognitive intervention improved overall memory of children at $P<0.001$. Importantly, this finding was found in a school setting.

Conclusion: The motor cognitive intervention may assist in organizing focused training sessions for both appropriate for age developing children and those who have learning disabilities to enhance their working memory performance.

Key words: Learning disabilities, working memory, motor-cognitive intervention, exercise, cognitive abilities, primary school children, memory performance, school setting, Gujarat.

Introduction:

Learning disabilities (LD) are syndrome that affect an individual's capability to process, store, and recall information. Learning disabilities (LD) can cause problems with communicating, reading, writing, maths, and other skills, which can have an influence on a person's academic and social functioning (1). As reported by the Centres for Disease Control and Prevention (2021), round about 1 in 6 children in the United States have one or more developmental disabilities, with LD being highly prevalent (2).

In the United States, the prevalence of learning disabilities is estimated to be around 10 percent of the population. This means that approximately 1 in 10 people have a learning disability. However, this number can vary depending on the specific type of learning disability and the criteria used to diagnose it. For example, dyslexia, a reading disorder, is estimated to affect around 5-10 percent of the population (3). The prevalence of learning disabilities also varies by age group. Children are more likely to be diagnosed with a learning disability than adults, with estimates ranging from 5-15 percent of school-aged children (4).

The study conducted by Shah and Buch (2019) aimed to investigate the prevalence of specific learning disabilities (SLDs) among Gujarati medium primary school children. A multilevel screening approach was used among students aged 7-12 years and used National Institute of Mental Health and Neurosciences test for SpLDs. The study found that the overall prevalence of SLDs was 9.6%, with dyslexia being the most common type of SLD (5).

Working memory is a type of mental activity that enables your brain to temporarily retain and process information. People with Learning disabilities often experience difficulties of working memory which can affect their academic and social functioning. According to the research, individuals who has learning disabilities are often discovered to have memory disorders also. Interventions aimed at working memory may be helpful for improving educational outcomes (6).

Studies reported that children with learning disabilities including dyslexia, dyscalculia, or attention deficit hyperactivity disorder (ADHD) frequently struggle with working memory issues.(7) Children with dyslexia, for instance, could find it challenging to maintain letter sounds in working memory when decoding words, whereas those with dyscalculia might find it challenging to recall math facts or mental arithmetic techniques (8)(9).

Several research studies have highlighted the association between working memory deficits and academic difficulties, as well as social and emotional challenges (10). Reading comprehension, math problem-solving, and writing expression are just a few of the academic learning activities that depend on the working memory, a crucial cognitive activity. Poor working memory in children with LD may make it difficult for them to complete these tasks and stay up with their peers (11). Working memory issues can also affect children's attention and behavioural control, making it difficult for them to control their emotions and behaviour in social situations (10).

Improving working memory in school children is important for academic success. Numerous interventions have been found to be successful in enhancing working memory such as working memory training (12), Cognitive-Behavioral Therapy (CBT) (13), physical exercise (14), and mindfulness meditation (15).

There is evidence that suggests physical exercise helps to improve working memory in both children and adults. Exercise has been shown in studies to increase blood flow to the brain, which improves cognitive function., including working memory. One study found that school-aged children who engaged in aerobic exercise for 20 minutes before taking a working memory test performed better than children who did not exercise before taking the test (16). Another study found that adults who engaged in regular aerobic exercise had better working memory performance than adults who did not exercise regularly (17). Furthermore, an extensive examination of research investigating the influence of physical activity on cognitive abilities discovered that physical exercise can result in a beneficial impact on working memory, for both adults and children (18).

The exact mechanism by which physical exercise improves working memory is not fully understood, but it may be related to increased blood flow and oxygenation to the brain, as well as changes in brain structure and function (19). Overall, the evidence suggests that physical exercise may be a helpful method for enhancing working memory in both children and adults (14)(20)(21). The researcher assumes that based on a literature review motor-cognitive intervention, a type of physical exercise can be tested on inspiration children to improve their working memory performance.

Objectives:

The present research conducted to

- ✓ Assess prevalence of inspirational children,
- ✓ Assess the working memory performance among inspirational children
- ✓ Evaluate the effectiveness of motor-cognitive intervention on working memory performance among inspirational children.

Hypothesis (H_0): There is no significant difference between pre-test and post-test working memory performance of inspirational children among experimental and control group at 0.05 level of significance.

Methodology:

Research approach: A Quantitative research approach was considered the best to assess the impact of motor cognitive intervention on working memory of inspirational children.

Research design:

Phase -I: The prevalence of inspirational children among 3rd to 6th standard children of government primary schools, Anand District, Gujarat estimated Using a cross-sectional research approach.

Phase-II: Pre- and post-test control group designs using quasi-experimental research methods were employed to measure the impact of the motor cognition intervention on working memory performance of inspirational children studying in 3rd to 6th standard of government primary schools, Anand District, Gujarat.

Sample Size: Phase -I: 100 children who fulfilled the inclusion criteria; Phase- II: 16 children in experimental group and 15 children in control group who are at risk of developing learning disabilities and having either severe or moderate level working memory impairment.

Setting of the study: Government Primary Schools, Anand District, Gujarat.

Sampling technique: Non-probability, Purposive sampling technique.

Inclusion criteria: School going children who are studying in class 3rd to 6th (age 8-12 years), have no long-term physical ailment, according to the parents and willing to participate in the study.

Exclusion criteria: School going children who diagnosed with co-morbid psychiatric disorders like autism spectrum disorder, Attentional Deficit Hyperactivity Disorder (ADHD), severe depression, mental retardation has speech, vision or hearing impairment.

Independent variable: Motor-cognitive intervention

Dependent variable: Working memory performance of inspirational children

Ethical clearance: Institute Ethics Committee of CHARUSAT University, Changa approved the present study vide letter number CHA/IEC/ADM/20/08/699.

Description of tool: IHBAS SLD screening Questionnaire (2007) developed by Uday K. Sinha, used in phase I in which total 12 questions are there and this will be filled by teachers. Children who had 4 and above score will be considered at risk for developing learning disabilities and in second phase they assessed for their working memory performance by PGI children's memory scale. There are 10 subcomponents in PGI Children's memory scale which are remote memory, recent memory, mental balance, attention and concentration, delayed recall, immediate recall, retention for similar, retention for dissimilar, visual retention, recognition. Then obtained score of each child will be converted into percentile and interpretation made regarding their memory functioning. If the score of children ranges below 20th percentile then it is indicating severe memory deficit, if it is lies between 20-40 range it indicates moderate impairment in memory functions and if the child's memory is functioning at above 40 percentile it indicates just average functioning.

Data collection procedure:

The study was conducted on primary school children. A total of 100 students (boys and girls) represented classes from standard 3 to 6 who attended school regularly. The work was carried out in the academic year (2021–2022), starting from November 2021 to

January 2022. The students were divided into three groups (first group include 38 students in class 3, 42 students in class 4 and 20 students in 5^{th} class) with age ranging from 8 to 12 years old, of both sexes, and with average intellectual abilities. After obtaining informed consent from parents and teachers and ensuring confidentiality, all children were subjected to the following.

Step 1: Initially, government primary school children of 3^{rd} to 6^{th} standard screened for risk of developing learning disabilities by IHBAS SLD screening Questionnaire (2007) developed by Uday K. Sinha, children who had 4 and above score will be assessed for working memory performance.

Step 2: In second phase, children who had risk of developing learning disabilities examined for PGI children's memory scale and who had moderate and severe working memory impairment were assigned at random to experimental and control group. Children in the experimental group received motor-cognitive intervention for 20 consecutive days. It is 35 minutes of series of movements which strengthen the neural pathways of a child to learn and express executive function skills such as working memory. First children need to drink water and then perform brain button, hook up 1&2, cross crawl, thinking caps, positive points, lazy eight exercise instructed by researcher. After completing the 20th day intervention, both experimental and control group children were evaluated for their working memory functioning using the PGI children's memory scale, and the post-intervention scores were compared to the pre-intervention scores.

Results

A total of 100 completed screening proformas were gathered. There were 100 participants in the final sample, and 31 of them had specific learning difficulties.

Socio-demographic data presented that majority 64% of the children were girls and 34% were boys. Majority 48.4% of children belongs to age group of 9-10 years whereas 29% belongs to 8-9 years and 22.6% belongs to 10-11 years. The mean age of children is 9.32±0.85.

Table 1: Prevalence of Specific learning disabilities among elementary school children based on IHBAS SLD screening Questionnaire. (N=100)

Children	Frequency (%)
Possibility for specific learning disabilities	31 (31%)
Not having specific learning disabilities	69 (69%)
Total	100

Table 2: Proportion of sociodemographic variables and at risk of specific learning disabilities.

Sr No.	Demographic variables	Frequency (%) of total sample	Frequency (%) of at risk of specific learning disabilities.
1	**Age in years**		

	8 - 9	38 (38%)	09 (29 %)
	9 - 10	42 (42%)	15 (48.4%)
	10 - 11	20 (20%)	07 (22.6%)
2	**Gender**		
	Male	36 (36%)	12 (38.7%)
	Female	64 (64%)	19 (61.3%)
3	**Class**		
	3rd	39 (39%)	10 (32.2%)
	4th	41 (41%)	14 (45.2%)
	5th	20	07 (22.6)

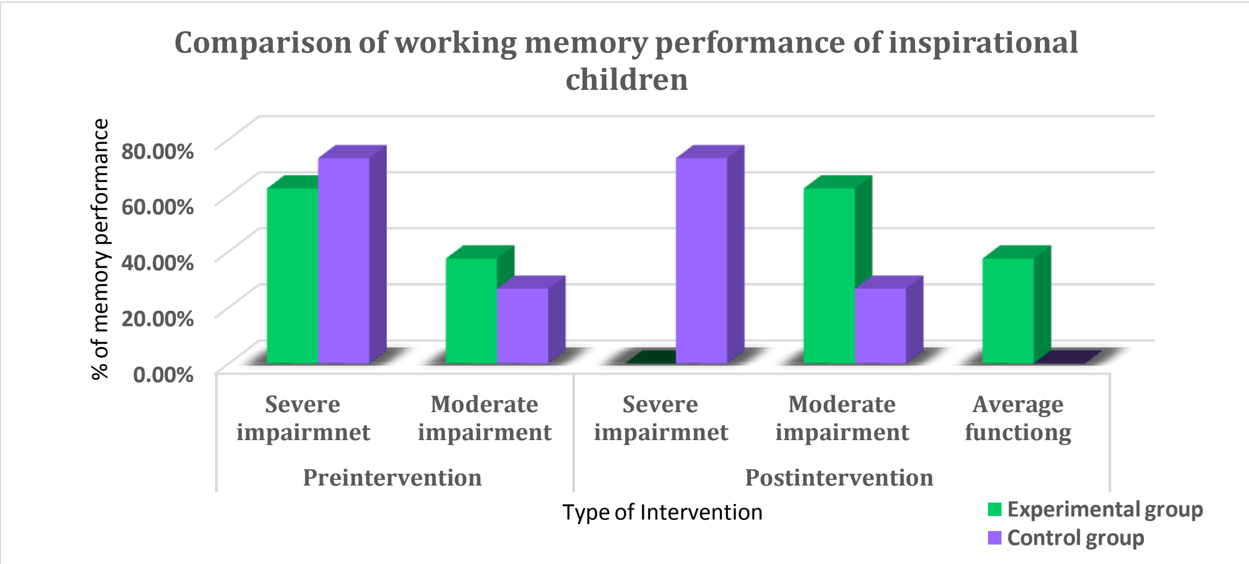

Figure 1: Comparison of working memory performance among inspiration children

Table 2: Working memory performance among children before and after intervention between experimental and control group.

Group		Mean	Standard Deviation (SD)	t test	Df	P Value
Control	Pre-test	38.47	4.64	3.263	14	0.006
	Post-test	39.67	4.59			
Experimental	Pre-test	39.75	5.77	11.757	15	<0.001*
	Post-test	54.19	7.41			

*p-value < 0.05 were considered statistically significant.

Table 2 indicates that mean value and SD of pre-intervention in control and experimental group is 38.47+4.64 and 39.75+5.77. Post- intervention Mean and SD value in control and experimental group is 39.67+4.59 and 54.19+7.41. Children's working memory performance varies between the experimental and control groups. The mean working memory performance in experimental group before intervention is 39.75 while in after intervention it became 54.19 whereas in control group pre-test is 38.47 and post-test is 39.67. In comparing both the groups statistically it is observed significant improvement in working memory performance of children in experimental group. Which means that working memory performance is different in both the situation and it is statistically significant. Therefore, the null hypothesis is rejected at a significance level of 0.05.

Table 3: Findings related to effectiveness of motor-cognitive intervention.

Group		N	Mean	Std. Deviation	t test	Df	P value
Difference	Control	15	1.20	1.42	10.04	29	<0.001*
	Experimental	16	14.44	4.91			

*p-value < 0.05 were considered statistically significant.

Table 3 illustrates that after intervention, the working memory functions of experimental group children improved evidently. Significant difference was found between the two groups are t=10.04 which is statistically significant (p<0.001).

Discussion:

Specific learning disorders (SLDs) are neurological conditions that impair a person's capacity to successfully acquire, process, or use information. They are characterized by significant difficulties in one or more areas of academic achievement, such as reading, writing, math, or listening comprehension. The frequency of SLDs varies according to the specific type of learning disability and the diagnostic criteria. The present study reported the prevalence of learning disabilities among 3rd to 6th standard school going children is 31%. The findings of the present study are parallel with study conducted by Padhy et al. (2016) reported prevalence of learning disabilities 33.6% in school going children in a northern city of India (22). A fluctuating prevalence of 3%–10% had been seen in earlier SLD studies (23). Joseph JK, Devu BK (2022) conducted a systematic review and meta-analysis Prevalence and pattern of learning disability in India and communicated the prevalence of learning disability among Indian children ranges from 2.16% to 30.77% across the studies. The pooled prevalence of LD among children and adolescents is estimated to be 10.70% (95% CI: 7.10% to 14.3%), and the median age was 6–12 years (24). However, a research study conducted at Ernakulam, Kerala found that the prevalence of SLD was 16.94% (25). A study conducted by Shah, C. G., & Buch, P. M. (2019) in Gujarat reported prevalence of learning disabilities 9.6% (26). Our study had a higher prevalence compared to previous research studies. This could be because of the various researchers use varied diagnostic instruments and various populations under study.

After consecutive 20 days' motor-cognitive intervention which consist of 35 minutes every day; it is observed significant change in working memory performance of inspirational children whereas control group children received as usual classroom teaching. Experimental group children's working memory performance improved with "t" test value of 11.757 (P<0.001) which is statistically significant. There was a statistically significant difference in working memory performance between the experimental and control groups (t=10.04, p<0.001).

A study on the Effects of physical exercise on children with attention deficit hyperactivity disorder: evidence through a meta-analysis was conducted in 2019 by Zang. The 12-week physical exercise intervention led to significant improvements in working memory performance, suggesting that physical exercise may be a useful non-pharmacological intervention for children with ADHD. The study highlights the potential of physical exercise as a complementary intervention for children with ADHD. Incorporating regular physical exercise into daily routines may have a positive impact on cognitive function and academic performance and could be particularly beneficial for children with ADHD who may struggle with attention and working memory tasks (27). Another study findings are in consistent with that 12 weeks of specifically designed physical activity intervention led to preschool children's efficacy of working memory as well as manual dexterity, aiming and catching and global motor competence. The improvement in the efficacy and efficiency of working memory was positively related to the improvement in static and dynamic balance and global motor competence (28).

Furthermore, the study by Chaire et al. (2020) investigated the effects of acute physical exercise on working memory and attention-related neural oscillations in young adults. The results showed that a single bout of moderate-intensity exercise improved working memory performance and enhanced neural oscillations in the alpha and beta frequency ranges in brain regions involved in attention and working memory (29).

Overall, these studies suggest that physical exercise can have positive effects on working memory performance among children in India, including from low socio-economic backgrounds.

Motor-cognitive intervention is a type of physical exercise that focuses on both motor and cognitive abilities. This type of intervention typically involves structured activities that combine physical movement with cognitive tasks, such as balance exercises with simultaneous cognitive tasks like memory recall or problem-solving. It helps for brining attention and improving working memory of children in aspects of remote memory, recent memory, mental balance, attention and concentration, delayed recall, immediate recall, retention for similar, retention for dissimilar, visual retention, recognition.

Limitations:

As previously discussed, there are some limitations of present study as variation in the definition of learning disabilities, assessment methods used, and cultural and linguistic differences. Prevalence rates may vary depending on the age, gender, socioeconomic status, and other demographic factors of the population. For example, some studies may focus on school-aged children, while others may include adults. The actual process by which motor-cognitive intervention improves working memory is not fully understood. The effects of motor cognitive intervention on other body parameters like oxygenation of body and radiological changes in brain and its structure have not been checked.

Recommendations:

Results of this pilot study recommend the following to assess effectiveness of motor cognitive interventions.

- ✓ Sample size to be enhanced for generalization.
- ✓ Interventions frequency can be enhanced.
- ✓ To track the long-term effects on children's working memory performance, follow-up sessions must be scheduled at various intervals, such as 3 months, 6 months, 9 months, and so on.
- ✓ Motor cognitive intervention sessions can be monitored with EEG changes.
- ✓ Efficiency of motor cognitive intervention can be observed from vitals like heart rate, Blood Pressure, pulse rate, and respiratory rate.
- ✓ Biochemical changes can be observed in both experimental and control group.

Conclusions

From the above pilot study, it is observed that motor-cognitive intervention brought significant changes in working memory performance of experimental group children compared to control group children. This study's findings are consistent with those of other earlier research that showed the intervention group had improvements in cognitive control and working memory functioning following the application of physical exercise.

It is found that methodology of the study is found feasible, and intervention can be administered for consecutive 20 days for 35 minutes once in a day to observe clinically significant changes in working memory performance among inspirational children.

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