

## EFFECT OF BRAIN GYM AND WEB - BASED COGNITIVE TRAINING INTERVENTION ON VISUAL ATTENTION SPAN AND WORKING MEMORY IN CHILDREN WITH DYSLEXIA

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### ABSTRACT

Dyslexia is associated with a weak working memory and visual attention span of children that impacts the academic performance. This study aim is to measure the effect of brain gym and web-based cognitive training on visual attention span & working memory performance in children with dyslexia. This experimental study consists of two groups. Each group has 11 children. One group received a brain gym intervention with six Super space movements (Brain Buttons, Space Buttons, Earth Buttons, Thinking Cap, Cross Crawl and Hook-Ups) for 5 minutes on daily basis for 4 weeks and an another group received a web-based cognitive training for 5 minutes on daily basis for 4 weeks duration. Before and after the intervention digit span forward, digit span backward, spatial memory test, stroop test were assessed to check the working memory and visual attention span. Wilcoxon signed rank test was used to interpret the data. The statistical finding shows that there is a significant increment of visual attention span and working memory for the intervention groups. The study finding also shows the brain gym intervention successfully enhancing the participants working memory than the cognitive training intervention.

**Keywords:** Dyslexia, Brain Gym, Cognitive Training, Visual Attention Span, Working Memory.

### INTRODUCTION

Dyslexia is defined as a specific deficit in reading acquisition that cannot be accounted for by low IQ, poor educational opportunities, or an obvious sensory or neurological damage (World Health Organization, 2011). Dyslexia is divided into two forms: Developmental and acquired. This study is primarily about developmental dyslexia, i.e., dyslexia that begins in early childhood. Acquired dyslexia occurs subsequent to neurological insult, such as traumatic brain injury. Developmental dyslexia in children was first reported by morgan in 1896. The prevalence rates ranging from 5 to 10 percent of population. It is said to be 5 times more common in boys than girls (Halpern, 1992). The severity varies from mild to severe form. Dyslexia is associated with a weak working memory and visual attention span of children that impacts the academic performance.

Working memory is an early process of brain function that is crucial for learning process (Baddeley, 2012). It has the process of temporarily storing & manipulating information,

underlies performance in many other activities, including logical reasoning and reading comprehension. Working memory capacity has a strong relationship with general intelligence (Conway et al,2003; Kane et al,2005).

Visual attention span defined as the number of distinct visual elements which can be processed in parallel in a multielement display. Dyslexic children, like children with AD/HD, may have difficulty paying attention because reading may cause them to fatigue easily, and limits the ability to maintain concentration.

There is a relationship between Attention and Working memory. The ability to selectively process information (Attention) and to retain information in an accessible state (Working memory) are critical aspects of our cognitive capacities.

Many recent studies were conducted to improve the visual attention span and working memory function with simple body movement (Vicary et al,201; Sousa,2017) and brain training games (Durkin et al. 2013 ; Cardoso – leite & Bavelier,2014 ; Titz & Karbach 2014). Some studies found that there is a significant relationship between IQ level and Working Memory, so that working memory training were found to improve the IQ level of an individual (Norbert & Ksenija,2012; Smith,2015).

Brain gym is an intervention designed by Paul and Gail Dennison in 1970's to improve attention, memory and academic skills. (BGI,2014). It consists of 26 simple movements which activate both hemispheres of the brain through neurological repatterning to promote whole brain learning (Hyatt, 2007; Dennison & Dennison, 2007). These simple body movements often bring about dramatic improvements in areas such as; Concentration and focus, Memory, Physical coordination, Self responsibility, Organizational skills, Attitude and Academics such as reading, writing, math and test taking.

Educational Kinesthetic teaches movements of the body that can improve brain function. It is a noninvasive, drug free way of changing learning blocks into learning bridges. According to BGI, engaging in the movement of brain gym causes new neural pathways to grow.

The web-based cognitive training through a game called Lumosity it was developed by Lumos Lab to improve attention & memory of an individual. Since cognitive training exercises can be tedious, these exercises have been structured to make them more engaging and encourage long-term consistent usage. Brain gym and web-based cognitive training are two different approaches that focus on student engagement in activity to impact neural plasticity process and brain executive function.

Neural plasticity allows the neuron to regenerate both anatomically as well functionally & to form new synaptic connections. It happens when the needs of a metabolic neuron could be increased the increment of the intensity of brain stimulus (Leiman & Melillo,2015).

## AIM OF THE STUDY

This study aim is to measure the effect of brain gym and web-based cognitive training on visual attention span&working memory performancein children with dyslexia.

## OBJECTIVE OF THE STUDY

- To assess the effectiveness of brain gym exercise on Visual attention span & working memory among dyslexic children.
- To assess the effect of web-based cognitive training on Visual attention span & working memory among dyslexic children.
- To evaluate the effective treatment intervention for children with poor reading.
- To find out which component will improve with this intervention program.

## BACKGROUND OF THE STUDY

1. The conclusion of the study shows that there is an improvement in attention span after giving exercise program to young adults “Effect of brain gym exercises on the attention span in young adults” Chaitanya Kulkarni, Sanjivani Ramesh Khandale et al, Internal journal of advance research and development, Volume 4, Issue 4,(2019).
2. The conclusion of the study provides an evidence that brain training and brain gym intervention was successful in enhancing participants working memory performance “The effectiveness of brain gym & brain training intervention on working memory performance of student with learning disability" Bungawali Abduh, Mohd Mokhtar Tahar et al, Journal of ICSAR, Volume 2,(2018).
3. This study concludes that experimental group significantly enhanced their reading performance after working memory training “Working memory training improves reading processes in typically developing children” Sandra V.Loosli, Martin Buschkuehl, Walter J. Perrig, and Susanne M. Jaeggi et al, Child Neuropsychology,(2011).
4. The result of the study indicates that fundamental cognitive abilities such as working memory and visual attention is improving with a web-based application “Improvement of visual attention and working memory through a web-based cognitive training program” Michael Scanlon, David Drescher, Kunal Sarkar Lumos labs,(2007).

## NEED OF THE STUDY

- In India only a few studies have been done with brain gym and cognitive training intervention among children with dyslexia.
- As brain gym and cognitive training is a newly emerging technique, the positive results may benefit the treatment.

- This study may help to provide an alternative to parents and teachers & to provide appropriate learning stimulus to the dyslexic children that could fulfill the needs of students in school and at home.

## **HYPOTHESIS**

### **NULL HYPOTHESIS:**

There will be no significant effect of brain gym and web-based cognitive training on visual attention span & working memory performance in children with dyslexia.

### **ALTERNATIVE HYPOTHESIS:**

There will be significant effect of brain gym and web-based cognitive training on visual attention span & working memory performance in children with dyslexia.

## **METHODOLOGY**

Study Design: Experimental Study

Study Type: Pre Test - Post Test

Study Duration: 4 Weeks

Study Setting: Absolute Therapy Care, Chennai.

Sample Size: 12

Sample Selection: Convenient Sampling.

## **INCLUSION CRITERIA**

- Participants in the age group of 8-10 yrs.
- Male children were taken.
- Dyslexic children with mild to moderate category [according to dyslexic assessment from DAI].
- Able to read the color names.
- Able to follow verbal commands.

## **EXCLUSION CRITERIA**

- Severe Dyslexic children [according to dyslexia assessment from DAI].
- Children with auditory and visual problem.

- Children with physical disability.
- Known case of any cardio respiratory problems.

## **OUTCOME MEASURE**

- Digit span test and spatial memory test to assess the working memory function.
- Stroop test to assess the visual attention span.

## **TOOLS USED**

Mobile device using to measure digit span test and spatial memory assessing from the website ([www.memorylosttest.com](http://www.memorylosttest.com)).

Stroop test assessing from the website (<http://faculty.washington.edu>)

Lumosity game

## **PROCEDURE**

All the participants were taken according to inclusion and exclusion criteria. Further the participants parents were explained about the purpose and procedure of this study by their local language and an Informed consent was obtained from the parents. Total 22 male participants in the age group between 8 and 10 were included in the study. Severity of dyslexia was screened and referred by a psychologist. In that, Mild to moderate category of dyslexic children's were taken. Two groups were separated, One group received a brain gym intervention with six Super space movements (Brain Buttons, Space Buttons, Earth Buttons, Thinking Cap, Cross Crawl and Hook-Ups) for 5 minutes on daily basis for 4 weeks and an another group received a web-based cognitive training for 5 minutes on daily basis for 4 weeks duration. Before and after the intervention digit span forward, digit span backward, spatial memory test, stroop test were assessed. Subject's outcome data was recorded at the end of 4<sup>th</sup> week and the data was plotted as statistical frame work.

## **GROUP – A (BRAIN GYM EXERCISE DESCRIPTION)**

Brain Button - Place right hand on the sternum and left hand on the abdomen and then slowly breathe in and out.

Space Button - Place pointer and middle fingers on upper lip. The other hand should rest on the back just above the tailbone.

Earth Buttons- Place the fingertips of one hand on the upper lip. Place the other fingertips about six inches below the belly button. Hold these points for four to six complete breaths. Change hands in order to activate both the right and left sides of the brain.

Thinking Cap- Fold ears back and massage beginning with the top of the ear and ending with the bottom of ear lobe.

Cross Crawl - It can be done with sitting or standing. Right hand elbow is used to touch the left knee and vice versa.

Hook Ups -Crosses the left ankle over the right, then puts both arms out in frontof the body and crosses the left wrist over the right. Interlace the fingers and bring the hands up toward the chest. Eyes should be closed and should breathe deeply and relax for about sixty seconds.

## **GROUP – B (COGNITIVE TRAINING INTERVENTION)**

The cognitive training program is composed of a set of exercises designed to improve attention, working memory, processing speed, problem solving, and response inhibition among other executive processes.

### **Training Exercises Related to Working Memory:**

Memory match and Monster garden both used to improve working memory. Memory Match is a speeded n-back task where users must compare the current stimulus with those presented previously. The goal of Monster Garden is to navigate through a maze while relying on spatial memory to avoid obstacles. The number of obstacles increases as the user's ability to navigate the maze improves.

### **Training Exercises Related to Visual Attention:**

Train of thought is used to improve attention. In this game, the players direct the train to station of same color. Flip the switch in the track to direct the train to same color station.

LUMOSITY

## **DATA ANALYSIS**

The collected pre and post test data were analyzed and tabulated using wilcoxon signed rank test by SPSS trial version 22. For the descriptive statistics, the mean and standard deviation were calculated. The results were tabulated and the graph were plotted accordingly.

**TABLE – 1**

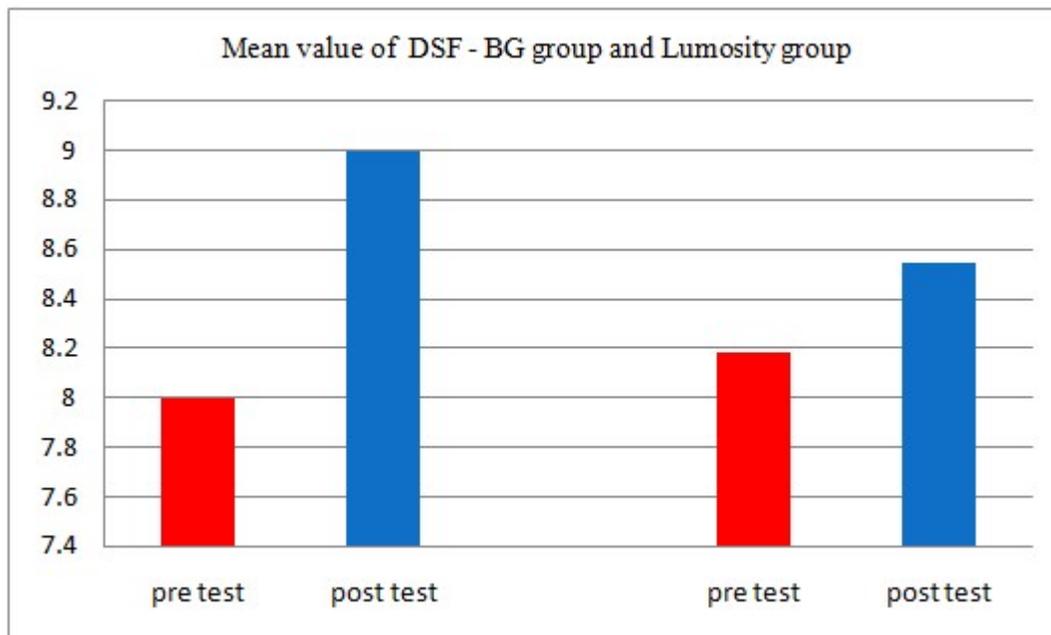
PRE AND POST TEST VALUE OF DIGIT SPAN FORWARD IN GROUP A SUBJECTS TRAINED WITH BRAIN GYM EXERCISES AND GROUP B SUBJECTS TRAINED WITH COGNITIVE TRAINING GAME (LUMOSITY)

DSF	MEAN		SD		Z-VALUE	P-VALUE
	PRE	POST	PRE	POST		
GROUP A	8.00	9.00	1.414	0.894	-2.636	0.008
GROUP B	8.18	8.55	1.471	1.440	-1.633	0.102

From the table 1, the descriptive statistics such as mean and standard deviation of pre test and post test was calculated. It is found that the pre test and post test value of Group A is significant ( $p < 0.05$ ) who are trained with Brain gym exercises and the pre test and post test value of Group B is not significant ( $p > 0.05$ ) who are trained with cognitive training game.

**GRAPH – 1**

PRE AND POST TEST VALUE OF DIGIT SPAN FORWARD IN GROUP A SUBJECTS TRAINED WITH BRAIN GYM EXERCISES AND GROUP B SUBJECTS TRAINED WITH COGNITIVE TRAINING GAME (LUMOSITY)



**TABLE – 2**

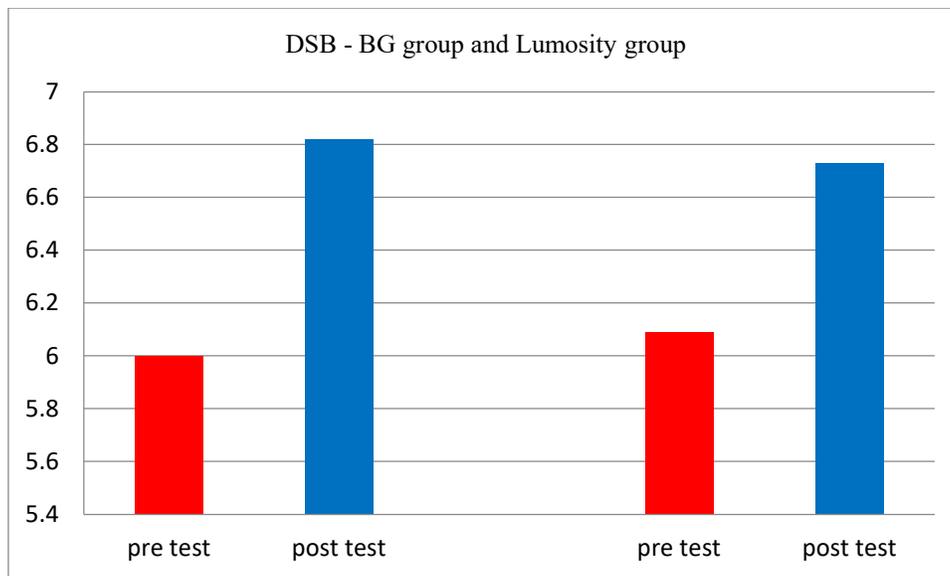
PRE AND POST TEST VALUE OF DIGIT SPAN BACKWARD IN GROUP A SUBJECTS TRAINED WITH BRAIN GYM EXERCISES AND GROUP B SUBJECTS TRAINED WITH COGNITIVE TRAINING GAME (LUMOSITY)

DSB	MEAN		SD		Z-VALUE	P-VALUE
	PRE	POST	PRE	POST		
GROUP A	6.00	6.82	1.789	1.401	-1.913	0.056
GROUP B	6.09	6.73	2.023	0.190	-1.311	0.190

From the table 2, the descriptive statistics such as mean and standard deviation of pre test and post test was calculated. It is found that the pre test and post test value of Group A is significant ( $p < 0.05$ ) who are trained with Brain gym exercises and the pre test and post test value of Group B is not significant ( $p > 0.05$ ) who are trained with cognitive training game.

**GRAPH – 2**

PRE AND POST TEST VALUE OF DIGIT SPAN BACKWARD IN GROUP A SUBJECTS TRAINED WITH BRAIN GYM EXERCISES AND GROUP B SUBJECTS TRAINED WITH COGNITIVE TRAINING GAME (LUMOSITY)



**TABLE – 3**

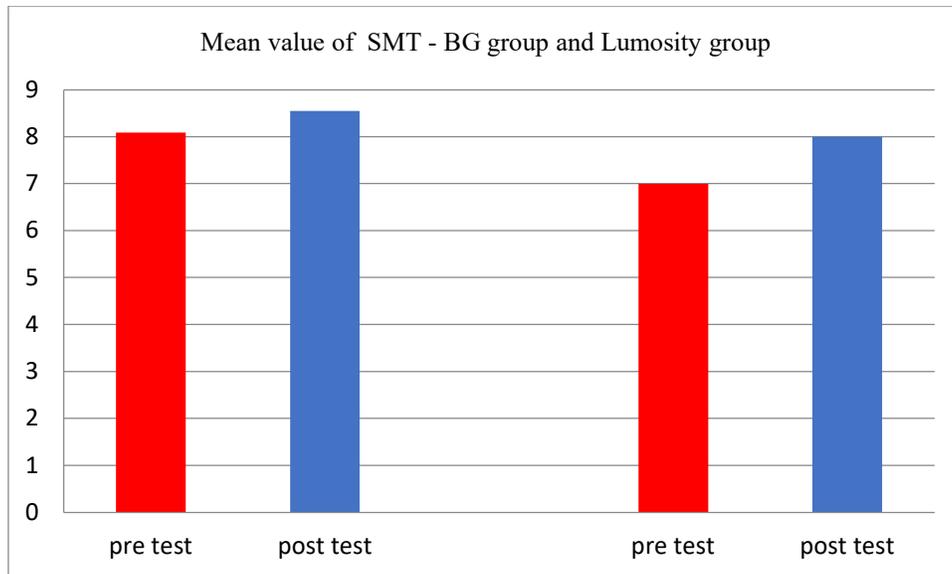
PRE AND POST TEST VALUE OF SPATIAL MEMORY TEST IN GROUP A SUBJECTS TRAINED WITH BRAIN GYM EXERCISES AND GROUP B SUBJECTS TRAINED WITH COGNITIVE TRAINING GAME (LUMOSITY)

SMT	MEAN		SD		Z-VALUE	P-VALUE
	PRE	POST	PRE	POST		
GROUP A	8.09	8.55	1.375	1.368	-2.236	0.025
GROUP B	7.00	8.00	1.342	1.549	-2.598	0.009

From the table 3, the descriptive statistics such as mean and standard deviation of pre test and post test was calculated. It is found that the pre test and post test value of Group A is significant ( $p < 0.05$ ) who are trained with Brain gym exercises and the pre test and post test value of Group B is also significant ( $p < 0.05$ ) who are trained with cognitive training game.

**GRAPH – 3**

PRE AND POST TEST VALUE OF SPATIAL MEMORY TEST IN GROUP A SUBJECTS TRAINED WITH BRAIN GYM EXERCISES AND GROUP B SUBJECTS TRAINED WITH COGNITIVE TRAINING GAME (LUMOSITY)



**TABLE – 4**

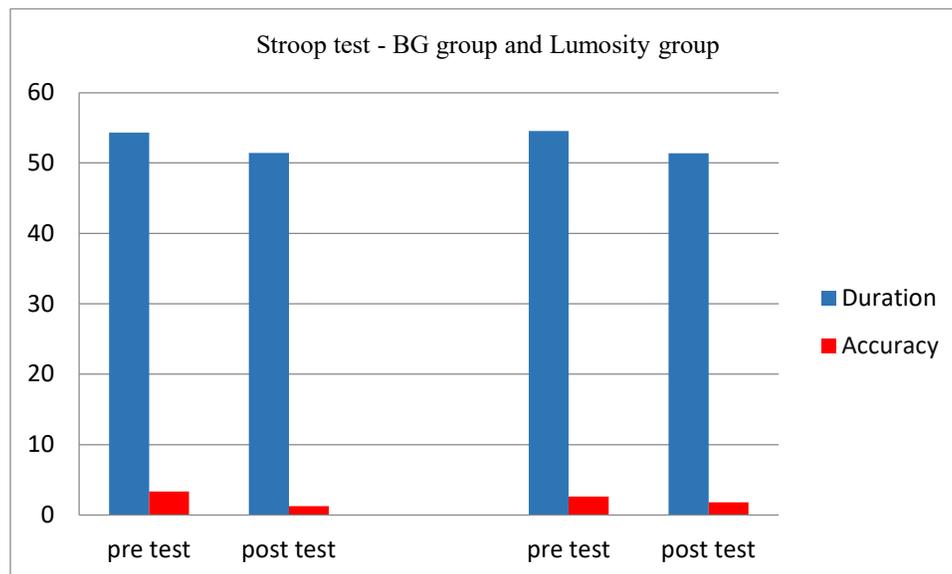
PRE AND POST TEST VALUE OF STROOP COLOR WORD TEST IN GROUP A SUBJECTS TRAINED WITH BRAIN GYM EXERCISES AND GROUP B SUBJECTS TRAINED WITH COGNITIVE TRAINING GAME (LUMOSITY)

STROOP TEST		MEAN		SD		Z-VALUE	P-VALUE
		PRE	POST	PRE	POST		
GROUP A	Duration	54.32	51.42	7.02	7.85	-2.845	0.004
	Accuracy	3.36	1.27	1.57	1.009	-2.699	0.007
GROUP B	Duration	54.55	51.37	8.362	7.291	-2.401	0.016
	Accuracy	2.64	1.82	1.362	1.537	-2.251	0.024

From the table 4, the descriptive statistics such as mean and standard deviation of pre test and post test was calculated for stroop test. It shows that the pre test and post test value of Group A is significant ( $p < 0.05$ ) who are trained with Brain gym exercises and the pre test and post test value of Group B is also significant ( $p < 0.05$ ) who are trained with cognitive training game.

**GRAPH – 4**

PRE AND POST TEST VALUE OF STROOP COLOR WORD TEST IN GROUP A SUBJECTS TRAINED WITH BRAIN GYM EXERCISES AND GROUP B SUBJECTS TRAINED WITH COGNITIVE TRAINING GAME (LUMOSITY)



## RESULTS

In table 1, the mean pre test values was compared with mean post test values of digit span forward test in Group A subjects trained with brain gym exercises and Group B subjects trained with cognitive training intervention. According to this table, the pre test and post test value of Group A is significant ( $p < 0.05$ ) and the pre test and post test value of Group B is not significant ( $p > 0.05$ ).

In table 2, the mean pre test values was compared with mean post test values of digit span backward test in Group A subjects trained with brain gym exercises and Group B subjects trained with cognitive training intervention. According to this table, the pre test and post test value of Group A is significant ( $p < 0.05$ ) and the pre test and post test value of Group B is not significant ( $p > 0.05$ ).

In table 3, the mean pre test values was compared with mean post test values of spatial memory test in Group A subjects trained with brain gym exercises and Group B subjects trained with cognitive training intervention. According to this table, the pre test and post test value of both Group A and B is significant ( $p < 0.05$ ).

In table 4, the mean pre test values was compared with mean post test values of stroop test in Group A subjects trained with brain gym exercises and Group B subjects trained with cognitive training intervention. According to this table, accuracy and duration for completion of stroop color word test is calculated. It shows that the pre test and post test value of both Group A and B is significant ( $p < 0.05$ ).

## DISCUSSION

The main findings of the study are discussed below. Brain gym exercises and cognitive training interventions have been used to improve visual attention span and working memory performance for dyslexic children. According to the result of this study, both intervention protocols were statistically significant to improve visual attention span. The brain gym intervention successfully enhancing the participants working memory and cognitive training intervention improved one component of working memory.

Brain gym includes several sets of exercises. These sets of brain gym exercises are useful for stress release and achievement of goals as well as organizational skills and performance skills. In the set of brain gym exercises cross crawl improves academic skills in spelling, writing, listening, reading and comprehension. Earth Button helps the learner to organize their visual field and become better coordinated. Space Button exercise helps to organizational skills and increase focusing abilities. Thinking cap exercise helps to focus attention and improve listening comprehension. Brain Button increases the flow of energy and switches the brain ON. Hook Ups helps to balance the body and improves equilibrium.

Overall, Brain gym helps in waking up a hearing mechanism so that we can hear with both ears together, remembering the study before/during a test. Brain gym exercises show that it can activate the whole mind & body. It also helps to improve attention & can be very beneficial for learners with ADHD. Practicing brain gym exercises improves balance & equilibrium. The subjects also showed that the brain gym exercises help communication become free and can be of particular help with speech impaired and autistic learners. Brain gym develops the brain's neural pathways the way nature does through movement. And also enhances learning and performance skills in all areas it helps the learners with specific learning & behavioural problems. There are almost 50% of nerves in the body are related to head & face and as tension is frequently held in the jaw muscle, this is highly beneficial for relaxing & calming the nervous system to relieve stress & tension and increases sensory intake.

The cognitive training is a treatment program to help individual's ability to function after a brain injury or brain injury or any other neurological event, such as stroke. The exercises are used as a tool to help achieve targeted therapeutic goals, such as enhancing self-esteem, training frustration tolerance, and developing problem solving strategies. It can also be used in school setting, where it may potentially ameliorate problems associated with learning difficulties. The goal is to improve memory, attention, perception, reasoning, planning, judgment, general learning and overall executive function.

Result of a study by Michael Scanlon et al., indicate training and improving Cognitive abilities such a working memory and visual attention is possible with web-based application.

A study by Stancey P. Bundens et al., concludes that Brain Gym Program would lead to improvement in motor skills. All students were pre- and post-tested using the Lincoln-Oseretsky Motor Development Scale. The results reflected an improvement for both the experimental and control groups. The average score for the experimental group was slightly higher than that of the control group.

Bungawali Abduh, Mohd Mokhtar Tahar et al., study result showed an improvement of brain gym and brain training intervention on working memory performance on students with learning disability.

## **CONCLUSION**

This study is a form of exploration of brain training interventions involving physical activity and web - based training to measure the visual attention span and working memory performance on children's with dyslexia. The brain gym intervention successfully enhancing the participants working memory than the cognitive training intervention, and the visual attention span of both the group is improved significantly.

## **LIMITATION AND RECOMMENDATIONS**

## LIMITATIONS:

- Sample size was small
- Limited follow up period
- Should be implemented for a longer period of time.

## RECOMMENDATIONS:

- A comparative study can be done between male and female dyslexic childrens.
- A similar study can be done with larger sample size.
- This exercise protocols can be done with other cognitive impairment subjects.

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