Effect of Brain Gym Training on Intelligence, Knowledge and Information Retention among Children with Developmental Disabilities

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Abstract

Background: Brain Gym is a simple and pleasant movement, consisting of 26 simple movements that are believed to enhance academic and behavioral performance by activating both hemispheres of the brain through neurological re-patterning to promote whole-brain learning. **Aim**: To evaluate the effect of brain gym training on intelligence, knowledge, and information retention among children with developmental disabilities. **Method**: A quasi-experimental research design was used to achieve this study. **Settings**: The study was conducted in integration classes at ten primary schools in Sohag City. **Subjects**: A purposive sample of 100 students with developmental disabilities as (autism and Attention Deficit Hyperactivity Disorder) was involved in this study were randomly assigned and divided into two equal groups of 50 students in each group. Group (I) was called the study group that was exposed to brain gym training and Group (II) was the control group. **Tools for data collection:** Tool I Howard Gardner Multiple Intelligence Test and Tool II: Achievement Retention Test. **Results:** The present study revealed that there were statistically significant differences between study and control groups and within study group before and after the application of brain gym technique with improvement after the application regarding all types of intelligence and achievement retention test total score. **Conclusion**: Brain gym training had a higher intelligence, knowledge, and information retention score in the study group than those of the control group. **Recommendations:** The brain gym technique should be incorporated in nursing theory and clinical education to improve the level of students' knowledge and retention.

Keywords: Brain gym Training, Intelligence, Knowledge and Information retention, children with developmental disabilities.

Introduction:

The human brain is not a static organ; it can be improved in a variety of ways, one of which is the brain gym, which was established in the 1970s by educators and reading experts Paul and Gail Dennison to improve a variety of outcomes including attention, memory, and academic abilities. This intervention requires participants to do a variety of motions to help the body recall motions learned in the early stages of life when they were learning to coordinate their hands, eyes, ears, and full body. Brain Gym is a sequence of 26 basic actions that are thought to improve academic and behavioral performance by engaging both hemispheres of the brain and encouraging whole-brain learning through neurological reprogramming by merging the left and right sides of the brain (**John & Ann, 2014**).

Positive self-talk, exercise, repetition, and stimulation are used in brain gym exercises to remap or build neural networks. Stress is a major issue while learning a new skill or replacing an old pattern with a new skill, hence breathing relaxation exercises are recommended before training. These workouts are really basic and suitable for people of all ages (**Simons et al., 2016**). Brain gym activities are mostly done by youngsters and young people. Adults and the elderly are now practicing these activities as well. There are a variety of advantages to using a brain gym. The following are the main advantages of brain gym exercises: it helps students learn things faster and easier, be more focused and organized, overcome learning challenges, attain their full potential, reach new levels of excellence and start & finish projects with affluence (**Ocampo et al., 2017).**

The lateralization, centralization, and

focalization techniques are classified into three categories with subcategories. The first category is lateralization/midline, which is concerned with how the left and right hemispheres interact. The second category is focalization, which is concerned with the development and reinforcement of neural pathways that link what people know today (at the back of their heads) to their ability to comprehend and articulate information (in frontal lobes). Relaxation techniques that aid in the re-establishment of neural networks between the brain and the body fall into the third category, centralization. It facilitates the transmission of electromagnetic flux across the body, allowing chemical and electrical reactions to take place during mental and physical activity **(Pederson, 2017).**

The first movement in the brain gym is lateralization/midline movement. It consisted of drawing horizontal eights in the air with hands or eyes in the Lazy 8s motion. The arms are alternately moved towards the opposing leg and vice versa in a cross-midline body action. Bilateral sketching practice in which both hands are used to sketch two images at the same time is known as the double doodle motion. The elephant motion, on the other hand, is a series of eight slow motions in which the eyes gaze beyond the hand and the entire body moves in lockstep with the arm movement. Moving the head forward and twisting from side to side creates a rolling neck action and rolling the hips one at a time in a motion of rocking the hips **(Grabe, 2018).**

The rib cage expands from front to back, left to right, and top to bottom to breathe in the belly breathing motion. Cross crawl sit-ups are done by sitting on your back with your knees and head raised, clasping your hands behind your head, touching one elbow to the opposing knee, and alternating. While doing an energizer action, sit comfortably, place hands on a desk (fingers pointing inward), breathe, and slowly raise the head and upper back. Close your eyes and imagine the letter X, then examine how your vision resembles it. The left, right, upper, and lower visual fields are all connected around a center of focus by your eyes working together **(Peach, 2017).**

The second movement, Focalization/ lengthen, is a variation of the Owl motion that re-establishes movement width by stretching the neck and shoulder muscles. The active arm action is also elevating the arm while keeping the head relaxed, lifting away from the head and front, back toward the ear. A sitting position with one ankle resting on the other knee and the foot flexed produces a foot flexing action. Bracing oneself against a wall, placing one leg over the other, and bending forward is the calf pump motion. The gravity glider motion also includes sitting comfortably, bending forward, allowing gravity to take over, crossing one foot over ankles, and reaching forward. While sitting on a padded surface on the floor with knees bent and feet together in front, leaning back with bodyweight on hands and hips, rocking body in small circles, or back and forth, is the whole rocker motion **(Naset., 2006, Robinson et al ., 2011).**

Centralization/energy workout is the third type of movement. The brain button's action begins with one hand massaging two places below the clavicle while the other rests on the navel. While one hand rests on the lower lip and the other rests on the pubic bone, the earth buttons are pressed. The balance button motion is performed by gently pressing the head back while holding the location where the skull lies over the neck. The space buttons are pressed with one hand on the top lip and the other on the backbone. Energy yawns are produced by yawning while massaging stiff areas of the jaw. Softly dragging ears backward and unrolling them with fingers, starting at the top of the ear and gently massaging them to the lobe, is associated with thinking cap action. The hook-up action is accomplished by crossing the left ankle over the right, intertwining fingers, and bringing them near to the chest. Relax by closing eyes and breathing deeply for a few minutes. Then release your hands, legs, and fingertips while inhaling deeply. It's gently brushing against the spot above the eye **(Gosbey, 2017).**

The impact of brain gym activities on the advancement of pupils' multiple intelligences can be measured based on their indirect influence on the brain via certain bodily areas. Gardner (1983-2007) characterized intelligence as a bio-psychological potential information process that may be triggered in a cultural situation to solve issues or develop goods, and he advocated multiple intelligences as a set of natural intelligence. It empowers students without confining them to a single mode of instruction. He defined eight intelligence kinds, claiming that each person has a unique combination of all intelligence. Musical/rhythmic intelligence,

visual/spatial intelligence, verbal/linguistic intelligence, logical/mathematical intelligence, bodily/kinesthetic intelligence, interpersonal, intrapersonal, naturalistic, and existential intelligence are all included **(Eggleston., 2015, Ewen et al., 2017).**

Musical/rhythmic intelligence is concerned with sound, rhythms, tones, and music sensitivity. People with strong musical intelligence can sing, play musical instruments, and produce music. They also have good absolute pitch, sensitivity to tone, melody, and timbre. Visual/spatial intelligence, on the other hand, is concerned with spatial judgment, the ability to picture with the mind's eye, the ability to accurately interpret the visual world, and the ability to alter and modify one's initial views through mental imaging. Artistic design, map reading, and interacting with objects are all functional components of spatial intelligence **(Gardner, 2012).**

Verbal–linguistic intelligence also includes the ability to use words effectively for reading, writing, speaking, storytelling, and memorizing words, dates, and languages. Language competence is required for explanations, descriptions, and expressiveness. Furthermore, logical/mathematical intelligence is concerned with logic, abstractions, numbers, logical reasoning, problem-solving, critical thinking, and the ability to comprehend the basic principles of the causal system. The foundations of physical–kinesthetic intelligence are the capacity to control one's physical activities and the ability to handle materials skillfully. This necessitates the capacity to train reactions, as well as a strong sense of time and physical action direction. Physical pursuits such as athletics, dance, acting, and creating are favored by those with high bodily-kinesthetic intelligence. Gardner considers athletes, dancers, musicians, actors, and police officers to be suitable professions **(Barnum, 2003).**

Interpersonal intelligence is defined as sensitivity to mood fluctuations, sentiments, temperaments, motivations, and the ability to collaborate in a group situation. People with high interpersonal intelligence can communicate effectively, sympathize easily with others, lead or follow, and enjoy debate and discussion. According to Gardner, they are most suited for salespeople, legislators, managers, teachers, and social workers. In contrast, intrapersonal intelligence is concerned with introspective and self-reflective capacities. This refers to a comprehensive understanding of oneself, including one's talents and weaknesses, as well as the ability to predict one's behaviors and feelings. Naturalistic intelligence also entails gathering and connecting information with one's natural surroundings. It is founded on ecological receptivity, which is deeply rooted in a sensitive, ethical, and holistic perspective of the universe. It is a classification system for animal and plant species. Furthermore, existential intelligence is described as the ability to be sensitive to, or to have the capability to comprehend, deep issues about human existence, such as the meaning of life, why humans are born and die, and so on **(Kovalik, 2019, Robinson et al., 2011).**

Significance of the study:

The estimated number of children ever diagnosed with ADHD, according to a national parent survey is 6.1 million (9.4%). This number includes: 388,000 children aged 2–5 years. 2.4 million children aged 6–11 years. Children with Attention Deficit Hyperactivity Disorder (ADHD) or Learning Disabilities were the topic of research. Children with autism, on the other hand, still require interventions in areas that Brain Gym claims to help, such as intelligence, knowledge, and information retention **(Danielson et al., 2018)**.

Academic achievement and knowledge retention, which relates to how far a student, instructor, or institution has progressed toward their short or long-term educational objectives, can also be used to assess brain gym. Academic achievement is best assessed promptly following the completion of a course. It received a new function, which is measuring information retention if it was measured after some time of at least 21 days from the course completion **(Areepattamannil, 2018)**. Hence, the study aimed to evaluate the effect of brain gym training on intelligence, knowledge, and information retention among children with developmental disabilities

Operational definitions:

Developmental disabilities: are a group of conditions due to an impairment in physical, learning, language, or behavior areas. These conditions begin during the developmental period, may impact day-to-day functioning, and usually last throughout a person's lifetime.

Educational Kinesiology or Brain Gym:

It is an approach to learning directed toward specific neurological effects, to the clarification

and implementation of life goals. The word kinesiology means "the science of movement", and so Brain Gym is based on the principle that we can educate the whole person through movement.

Retention of learned information: can be defined as having the information stored in long-term memory in such a way that it can be readily retrieved, for example, in response to standard prompts.

Aim of the study:

To evaluate the effect of brain gym training on intelligence, knowledge, and information retention among children with developmental disabilities

Research Hypotheses:

- Children with developmental disabilities who will be exposed to the brain gym training will get higher scores in multiple intelligence tests than those who did not receive it.
- Children with developmental disabilities who will be exposed to brain gym training will get higher scores in knowledge tests than those who did not receive it.
- Children with developmental disabilities who will be exposed to brain gym training will get higher scores on retention tests than those who did not receive it.

Subjects and methods:

Research design:

A quasi-experimental research design was used to achieve this study.

Settings: The study was conducted at all ten primary schools in the integration classes in these schools in Sohag City which included Ahmed Deaf Allah, Elnaser, Adfa El-Mashtraca, Osma Abo Zaid, Elthad, El-Tahrere, El-Bohoth, El-Taysser, El-Galaa, and El-Telol primary schools.

Subjects:

A purposive sample of 100 students with autism and ADHD was involved in this study were randomly assigned and divided into two equal groups of 50 students in each group. Group (I) called the study group that was exposed to brain gym training and Group (II) the control group during the first semester of the academic year (2020-2021), who net the following

inclusion criteria such as primary school children suffering from ADHD and autism, from both sex, aged from 7 to 12 years old, and their parents agree to participate in the current study.

Sample size calculation:

In this study, The sample was calculated using (Epi-info statistical package, version 7.2, designed by the CDC (Center for Disease Control and Prevention) with 80 percent power, a value of 2.5 is chosen at the acceptable limit of precision (D) at 95 percent confidence level (C1), with expected prevalence 10%, worst acceptable 25%. As a result, the sample size was estimated to be 100 of children to guard against the non-response rate.

Tools for data collection:

Data for the study was collected using the following two tools:

Tool (I): Part (I) child's characteristics, medical history, and academic characteristics sheet. It was developed by the researchers after reviewing the related literature and included age, gender, educational level, the age when autism was discovered, duration of disease, and degree of disability.

Part (II): Howard Gardner Multiple Intelligence Test: This tool was developed by Gardner in 2007 (Gardner, 2007). The researcher used it to test the many bits of intelligence of different students. It had 102 elements on a scale of (Y) present and (N) absent. The overall score was determined by subtracting the score of (N) from the total score of (Y) (Y). For all pupils, the median was computed for each intelligence, and a graph was drawn to determine which intelligences were preferred above the graph line (with a positive score) and which intelligences were not favored below the line (with a negative score). The student's intelligence types were determined as linguistic/ verbal, logical/ mathematical, spatial/ visual, bodily/ kinesthetic, musical, naturalistic, existential, interpersonal, and intrapersonal. This tool was attached with socio-demographic and academic characteristics sheet includes as age, sex, GPA, English level, and computer skills.

Tool II: Achievement Retention Test: After reviewing pertinent literature and course objectives, the researcher developed this measure to assess students' achievement and information retention (Barnum, 2003). True and false questions (10 items/10 grades) and multiple-choice questions (20 items/20 grades) were the two types of questions. Strong achievement/retention levels ranged from 30 to 20, moderate achievement/ retention levels ranged from 9 to 10, and low achievement/ retention levels ranged from 9 to less. The better the achievement and retention, the higher the score.

Method

- An approval from the Ethical Research Committee and the Dean of the Faculty of Nursing and the Head of the Pediatric Nursing Department at Sohag University after explaining the study's purpose and assuring the privacy, anonymity, and confidentiality of the collected data

- An official written permission to conduct the study was obtained from the directors of the selected setting after an explanation of the aim of the study.

Development of the study tools:

Tool I was developed, tool II was adopted from **(Gardner. 2007) and (Barnum, 2003).**

Validity of the tools:

The content validity of the tools, their clarity, appropriateness, and relevance was reviewed by five experts professors, three experts professors in the pediatric nursing field, and two experts' professor's Nursing Education field before using it with the responsive mothers in the study. No modifications were done according to the panel judgment to ensure clarity of sentences and appropriateness of the content.

Reliability of the tools:

Reliability of the tools was done using a test-retest method. All tools were tested by Cronbach's alpha test, and they were reliable, with a test coefficient Cronbach's Alpha value for the tool I was 0.748, and for tool, II was 0.702.

Pilot study

A pilot study was carried out on 10% of the sample (10 students with autism) to observe the clarity and testing of the feasibility of the research process. No modifications were done. Students with autism involved in the pilot study were included in the study.

Ethical considerations:

Before starting the research, official permission was obtained through an issued letter from the Dean of Faculty of Nursing. The researchers met the directors of the selected setting to clarify the purpose of the study and take their approval. Written consent was obtained from the students with autism to participate in the study after the aim of the study was explained to them. Written consent was obtained from students' parents to gain their cooperation. The researchers informed the students with autism and **ADHA** that, the study was voluntary, they were allowed not to participate and they had the right to withdraw from the study at any time, without giving any reason. Moreover, they were assured that their information would be confidential.

Data collection:

Data collection was started and continued for 3 months (from October 2021 to December 2021). The study tools were used as follows; Tool I was used twice: first as a pre-test before the application of brain gym and secondly as a post-test immediately after the application. Tool II was used three times: once as a pre-test before the application, second as a posttest immediately after the application, and finally as retention test 30 days from ending the application.

The study was carried out through three phases:

1. **The preparatory phase:** Researchers employed adequate researcher preparation and technique throughout this phase to try to uncover the true meaning of the new concept.

a. Researcher preparation

- Reading all available evidence on brain gym methodology, new and old, until the time of data collection from books, digital libraries, and websites, including national and international studies on the topic.
- Self-training on brain gym technique movements.

b. Content preparation

- To incorporate the brain gym methods inside the original instruction hour, the researchers established a timetable plan for the original lesson period.

2. **The Implementation phase:**

During this phase, the researcher used tools I and II to assess students' multiple intelligences

and knowledge for both the study and control groups. It began during the first semester of the academic year, 2020-2021. The researchers divided each lesson into four sessions, each of which lasted 25 minutes and included 20 minutes of subject explanation and 10 minutes of break during which the students have applied brain gym exercises of three categories.

In the intervention group:

Completing Brain Gym activities was the focus of the Brain Gym intervention. Participants executed four moves at the start of the session. Because Brain Gym does not propose a certain number of activities; movements were chosen to reflect one movement activity from each category (Midline Movements, Energy Exercises, Deepening Attitudes, and Lengthening Activities). Because of the problematic positioning of the hands-on bodily parts, some Brain Gym movements (e.g. Space, Earth, Brain, and Balance Buttons) were excluded (e.g. tailbone and groin areas). All other Brain Gym movements, on the other hand, were included. Depending on subject availability, sessions were held 2-3 times a week for 7-8 weeks. The subjects selected one of four cards, each illustrating a movement from one of the four categories. By describing and replicating the movement, the instructor guided the subject through the task. The movement activity was kept going until the individual stopped moving, was asked to stop, or 30 seconds had passed. Thirty seconds was chosen because it is the suggested minimum length of time for Brain Gym exercises **(Dennison & Dennison, 2017).**

In the control group:

To assess wether Brain Gym was effective, a control intervention was compared. The control intervention consisted of walking in the hallways outside of the classroom (8-10 minutes).

3. The Evaluation phase:

During this phase, researchers tested students in both the study and control groups to evaluate their multiple intelligences and knowledge level using the tool I, II immediately at the end of the application, and their information retention level using tool II 30 days after the application ended.

Statistical analysis:

The IBM SPSS software package version 20.0 was used to examine the data provided on the computer. IBM Corp., Armonk, NY Numbers, and percent were used to describe qualitative data. The mean and standard deviation were used to describe numerical data. The significance of the acquired results was determined at a 5% level of significance.

Results:

Table (1) represents that the children' age in both studied groups ranged from 7-> 10 years (56% and 54%) respectively, and (64% and 60%) of them were boys in brain gym group and control group respectively. Concerning educational class, 54% of children in the brain gym group were in one to third class compared to 58% in the control group. The table showed also when autism and ADHD was discovered, and the age of studied children was 2->5 among (64% and 70%) in brain gym group and control group respectively.

Regarding the duration of disease (58% and 62%) of children have the disease from less than one year in both the studied groups respectively, also, 44% and 48% of them had a moderate degree of autism in both groups respectively. Also, less than one-half of both study and control groups (48%, 44%) respectively had very good Math level and less than one-third of both groups had very good English level (32%, 30%). No statistically significant differences were identified between the study and control groups.

Table (2) shows a comparison of the median of the study and control groups' students according to their intelligence before and after using the brain gym. It was discovered that the study group's median of all sorts of multiple intelligences increased in favor of after the application (5,7,6,5,6,5,6,7,6)(-1,3,-2,3,2,3,4,2,2) correspondingly. There was also a statistically significant difference in all types of multiple intelligences and total score between the study and control groups, as well as within the study group, before and after the application of the brain gym approach, with (P=0.-000) in favor of the study group after the application. In the control group, the median remained virtually the same as before.

Figures (1) showed a comparison of the median of the study group students' multiple intelligences before and after using the brain gym. It was observed that the study group's score were higher after the application than before, even though linguistic and musical intelligences had been on the decline before the application.

In **figure (2),** showed a comparison of the

median of the control group' students' multiple intelligences before and after using the brain gym, it was observed the control group's scores are practically similar before and after one month of the application, whereas musical intelligence is on the negative side before and after.

Table (3) illustrates the mean and standard deviation of the research and control groups' achievement retention tests before and after using the brain gym. In comparison to the control group, it was discovered that after using the brain gym, the mean and standard deviations were higher (19.8 +- 0.5) (0.9+- 0.8), respectively. The retention test mean was the same as the accomplishment posttest, but the standard deviation was higher (19.8+- 0.8) than the achievement posttest.

The mean and standard deviations in the control group were higher after the application than before (8.3+- 2.2) (0.8+- 08), respectively, although the retention test means and standard deviation were lower (8+1.3). Furthermore, there was a statistically significant difference in

achievement and retention test results between the study and control groups, as well as within the study group, before and after the use of brain gym in favor of the study group as p (0.001). Before and after the application, there was no statistically significant difference in the control group.

Table (4): Reveals the comparison of the study and control groups' achievement retention levels before and after using the brain gym. After using the brain gym, all of the students in the study group improved from low to high achievement and retention levels. After the application, the students in the control group improved from a low level for all of them to a moderate level for nearly half of them and a high level for one-quarter of them, but their level was reduced in the retention level to more than two thirds and then returned to a low level again. There were statistically significant differences in achievement and retention tests between the study and control groups, as well as within the study group, before and after the use of brain gym in favor of the study group. (0.001).

Table (1): Frequency and percentage distribution of the studied children regarding their demographic characteristics and medical history, and academic characteristics (n=100)

Demographic characteristics	intervention Brain Gym group		Control group		P-value
	No	%	No	%	
Age					
• 7-> 10	28	56.0	27	54.0	1.000
• 10 -12	22	44.0	23	46.0	
Mean± SD	7.34±2.25		7.34±2.27		
Gender					
• Boys	32	64.0	30	60.0	1.000
• Girls	18	36.0	20	40.0	
Educational class					
• 1-3	27	54.0	29	58.0	.956
• 4-6	23	46.0	21	42.0	
Age (in years) when autism or ADHD discovered					
• 1	12	24.0	10	20.0	1.000
• 2-5	32	64.0	35	70.0	
• >5	6	12.0	5	10.0	
Duration of disease (in years)					
• <1	26	58.0	31	62.0	1.000
• 1-5	14	28.0	13	26.0	
• >5	7	14.0	6	12.0	
Degree of autism					
• Mild	17	34.0	16	32.0	1.000
• Moderate	22	44.0	24	48.0	
• Sever	11	22.0	10	20.0	
Math level					
• Poor	14	28.0	15	30.0	1.000
• Good	12	24.0	13	26.0	
• Very good	24	48.0	22	44.0	
English level					
• Poor	7	14.0	6	12.0	1.000
• Good	27	54.0	29	58.0	
• Very good	16	32.0	15	30.0	

Chi-square test - p-value for comparing between the two studied groups

Table (2): Comparison between the median of the study and control groups' students according to their multiple intelligences before and after one month of the application of brain gym

Multiple intelligences tool	Brain Gym intervention group		Z (P) control group	control group		Z (P)	Brain Gym group	control group
	Before	**After**		**Before**	**After**		**u$_p$**	**u$_p$**
	Minimum	-10	-6	-10		-10			
Linguistic	Maximum	10	10	5.8 (0.001)*	9	9	0.08 (0.928)	0.122
	Median	-1	5	1		2			0.001*
	Minimum	0	3	0		0			
Logical	Maximum	10	10	4.2 (0.001)*	10	9	0.03 (0.978)	0.255
	Median	3	7	2		2			0.001*
Musical	Maximum	11	11	6.2 (0.001)*	11	11	0.43 (0.671)	
	Median	-2	6		-2	-1			0.001*
	Minimum	0	3		0	0			
Visual	Maximum	10	10	3.4 (0.001)*	9	9	0.06 (0.951)	0.654
	Median	3	5		4	4			0.001*
Kinesthetic	Maximum	10	10	5.7 (0.001)*	10	10	0.06 (0.952)		0.001*
	Median	2	6		2	2			
	Minimum	-7	2		-7	-7			
Interpersonal	Maximum	9	9	4.2 (0.001)*	9	9	0.08 (0.934)	0.948
	Median	3	5		3	3			0.001*
Intrapersonal	Maximum	13	15	2.6 (0.001)*	13	11	0.07 (0.937)	
	Median	4	6		4	4			0.001*
	Minimum	0	4		0	0			
Naturalistic	Maximum	7	10	6.3 (0.001)*	7	7	0.08 (0.928)	0.663
	Median	2	7		2	2			0.001*
	Minimum	0	3		0	0			
Existential	Maximum	7	9	6.2 (0.001)*	7	7	0.05 (0.947)	0.844
	Median	2	6		2	2			0.001*

* P < 0.05 (significant) UP: Mann-Whitney test

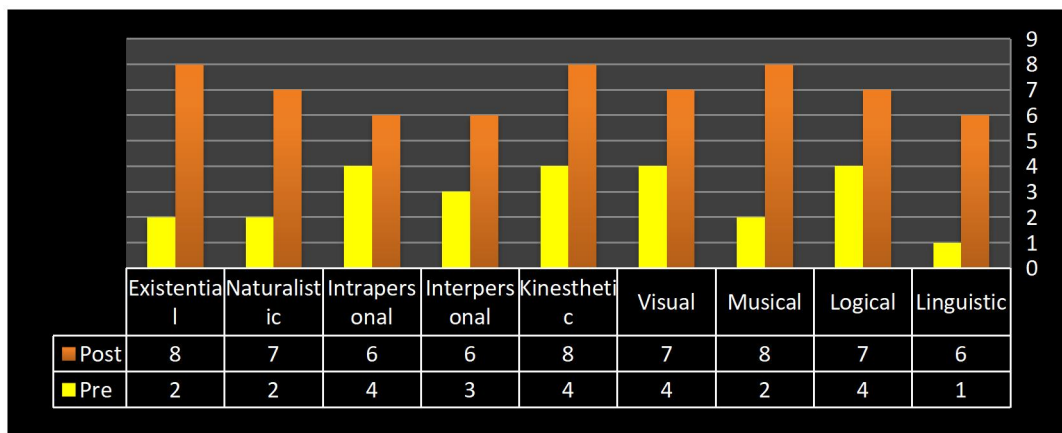(**) highly statistical significance at p < 0.001

Fig (1): Comparison between the median of the study group students according to theirmultiple intelligences before and after one month of the application of brain gym.
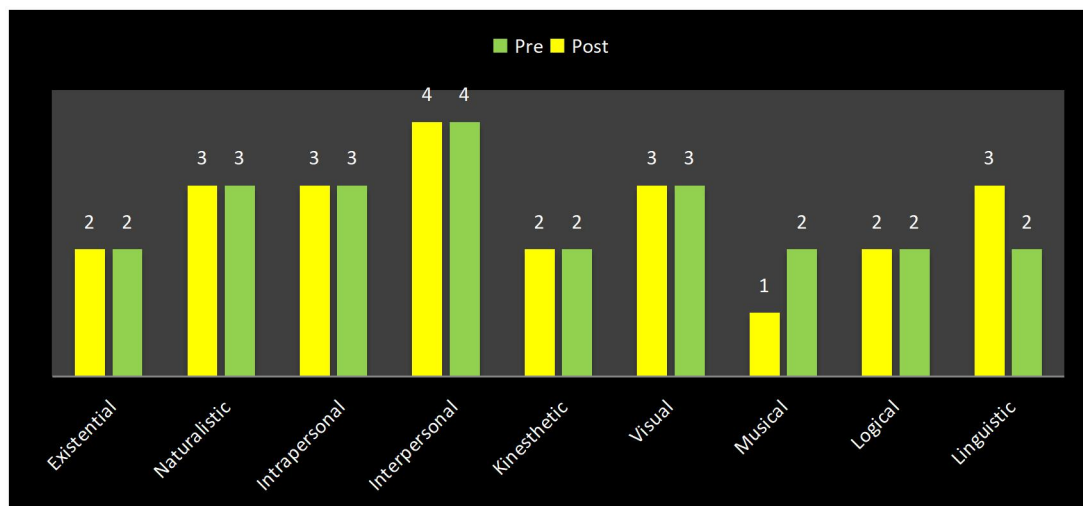
Figure (2): Comparison between the median of the control group students' according to their multiple intelligences before and after one month of the application of brain gym.

Table (3): Comparison between the mean and standard deviation of the study and control groups according to their achievement retention test before and after one month of the application of brain gym

Achievement	Study group		F (P)		Control group		F (P)	Study/control Achievement Test	Study/control Achievement Test	Study/control Retention Test
Retention Test								Pre Test	Post Test I	Post Test II
Achievement	Achievement	Retention		Achievement	Achievement	Retention		Up	Up	Up
pre Test	Post Test I	Post Test II		Pre Test	Post Test I	Post Test II				
Minimum 0.0	19.0	17.0		0.0	5.0	4.0				
Maximum 3.0	20.0	20.0	12.8	2.0	15.0	10.0	4.7	0.522	0.001*	0.001*
			(0.001)*				(0.056)			
Mean 0.9	19.8	19.8		0.7	8.3	8.0				
SD 0.9	0.5	0.8		0.8	2.2	1.3				

F: repeated measures ANOVA   * P < 0.05 (significant) ^{U}P: Mann-Whitney test   * P < 0.05 (significant)
(**) highly statistical significance at p < 0.001

Table (4): Comparison between the achievement retention level of study and controlgroup before and after the application of brain gym

Achievement	Achievement		Brain Gym group				P Achievement		Control group				P
			Achievement		Retention				Achievement		Retention		
			Pre Post		Post Test II			Pre Test	Post		Post Test II		
Retention Test	Pre Test		Test I										
	No	%	No	%	No	%	No	%	No	%	No	%	
Low	50	100	0.0	0.0	0.0	0.0	50.0	100	14	28.0	31	62	
Moderate	0.0	0.0	0.0	0.0	0.0	0.0	0.00 0.0 *	0.0	23	46.0	15	30	0.615
High	0.0	0.0	50.0	100	50.0	100	0.0	0.0	13	26.0	4	8	

T student t-test * statistically significant at p ≤ 0.05

Discussion

Brain Gym's basic focus is to use physical activity to gain access to various sections of the brain. These types of movements can be used to assist their students with conduct, comprehension or retention, organization, executive function, and communication. Brain Gym improves neurological function by

connecting and making parts of the brain more accessible for any given task. After using the brain gym, statistically significant differences were found between the study and control groups, as well as within the study group, in relation to all multiple intelligence types and the presence of massive elevation in the median scores of all intelligence types in the current study.

Results of the current study revealed that the brain gym application increased the study group's median of all sorts of multiple intelligences after the application. From the researchers' point of view, this result reflects the positive effect of brain gym application.

These results came in congruence with the study of **John, (2016),** who claimed that using brain gym resulted in considerable improvements in students' various intelligences and academic performance, as well as an increase in the medians of all intelligences after utilizing it. Furthermore, **Gilberto., (2017**) discovered that kids who conducted the brain gym activities for 20 minutes every day had higher reading and math intelligences than those who did not.

In a similar way, **Piengkes & Wolther., (2018**) who conducted a study about " Thestudy of English achievement for medical students by the integrated multiple intelligence brain based learning" and reported that the primary purpose of brain-based education is to assist students in the development of intellectual tools and different intelligences. Similarly, **Hannaford., (2018**) who studied " Teaching and assessing using multiple intelligences theory" and found that after utilizing brain gym, all students improved their reading comprehension scores by one year, and several students improved their total academic growth intelligences by nearly two years. Brain gym improved students' attention, self-awareness, confidence in spelling, math, writing, musical, reading, interpersonal, intrapersonal, and naturalistic intelligences, according to **McGovern., (2019**) who compare " the effect of brain based learning multiple intelligence pedagogy and traditional pedagogy on students' achievement and attitudes towards science" and detected that improving in students multiple intelligence as a result of the program.

In congruent with, **McCandliss., (2018)** who performed a research using the brain computed tomography to determine changes in multiple intelligences areas in both sides of the brain after using brain gym. The result confirmed that, there were differences in the brain images between the students who used brain gym and those who do not, as these areas became wider and deeper after the application. **Duman., (2017)** who studied " The effect of brain based learning on the academic achievement of students with different learning styles " and found that students' multiple intelligences and academic achievement scores were greater when they were taught utilizing brain gym rather than traditional teaching approaches like lectures and question- answer sessions.

Moreover, **Shaywitz & Audey., (2019)** who concluded in their study about " Brain based learning intelligences maturation" that, brain gym provided students with many opportunities for hands-on activities, collaboration with other students, enriched their learning and provided them with real life activities. Also it improved all their multiple intelligences skills which modified them from a personnot aware of their intelligence capability to an intelligent person with varying degrees in the nine intelligence types.

Concerning median of the study group students' multiple intelligences, result of the current study revealed that median of the study group students' multiple intelligences was higher after using the brain gym than before. This result reflects the need of the studied children to increase their intelligence and know adequate practicing to improve their academic achievement scores.

This result is in the same line with **Carol, (2016)** who studied " investigation of teachers' knowledge and application of brain-based learning theory relationship to their professional training " and the effect of brain gym on boosting certain intelligences using an electroencephalograph (EEG), and found that it improved students' spatial and language brain centers and helped them to get greater retention of the words that incorporated both hemispheres. Moreover, **Tilton, (2018)** who studied " Adult professional development: can brain-based teaching strategies increase

learning Effectiveness. " found that using brain gym movements improved students' success in the logical, mathematical, visual and kinesthetic intelligences. Whereas, **(Klink, 2019)** concluded that in his a study about " Brain-based learning: knowledge, beliefs and practices of college of Education" and reported that using brain gym in a socially isolated students, improved their interpersonal, intrapersonal, naturalistic and existential intelligences. These improvements were due to developing different brain networks which changed the brainprocesses underlying them.

In the current study, statisticallysignificant difference in achievement and retention assessments were identified between the study and control groups, as well as within the study group, after the application of brain gym.. Also all the students are converted from low achievement before the application to high achievement and retention level after the application. These results came in congruent with the study of **Ozeden & gultleen, (2014)** who studied the impact of using brain gym on the students' achievement and retention of information. The results showed that, brain gym had a positive impact on students' achievement and information retention.

In addition, **Demirel, (2015)** determined that after the application of brain gym, the study group students' got higher achievement test score than the control group. This result is sustained by **jeffer.,(2019)** who also examined the influence of brain gym on the retention test score after three weeks from ending the course of critical care nursing and found that students remained at the same level of achievement's score posttest, which meant that the student had a high information retention level compared to the achievement test.

Moreover, **McNamee, (2016)** who studied "The impact of brain-based instruction on reading achievement in classroom" and found that there was a positive correlation between the brain gym application and students' achievement and the retention levels improvement. The student level modified from low level in the pretest to high level in the achievement posttest and slightly decreased in the retention test than in the achievement posttest. These results supported by **Westor,(2019)** who conducted a study to find

out the effectiveness of brain gym in scientific understanding achievement test which revealed that students got a higher score in the posttest than the pretest with a highly statistically significant difference. This is to some extent similar to, **Duman, (2017)** findings whose study aimed to recognize the impact of using brain gym on the achievement and retention of students with different patterns of learning. The results indicated that; brain gym helped in improving the achievement and retention scores through improving the learning pattern of the students.

Results of the current study revealed that after using the brain gym, all of the students in the study group improved from low to high achievement and retention levels after the application. In the same way, Gozuyeşil & Dikici, (2017) determined the effect of brain gym on students' motivation and achievement retention. The results revealed that the students got in a vicious circle as after using brain gym, they became motivated to study and learn so they got a high scores in the achievement and retention tests .Also after they got a higher score, they became highly motivated to study and learn . Furthermore, William, (2018) concluded in his study about " Educating the brain and elevating the level " that there was a positive impact of brain gym program on students' academic achievement and retention, as they got a high score in achievement test and after one month the retention test decreased only from 0.5 to 1 grade. This result was in harmony with Cengelci, (2019) who studied "The effects of brain- based learning to success and retention in social studies" and revealed that the brain gym approach appeared to be more effective than the traditional teaching methods in enhancing the retention of the gained knowledge.

The researcher viewed the improvement of multiple intelligences and achievement retention test at the end product of brain gym application was due to the central effect of the three categories of brain gym which work on reunion of both brain hemispheres, improve neural pathway between brain cells and develop more relaxed technique against study stress. This leads to improving the abilities of both hemispheres, increasing attention, concentration, memory and achievement

abilities and develop advanced relaxation techniques. Also students became more motivated to learn and study in their homes after each session which decreased the load of study for achievement test and retained information test after three weeks of cessation of sessions.

Conclusion:

From the findings of the present study, it can be concluded that brain gym training had a higher intelligence, knowledge, and information retention score in the study group than those of the control group.

Recommendations:

Based on the current study findings, it can be recommended that

- The brain gym technique should be incorporated in nursing theory and clinical education to improve the level of students' knowledge and retention.
- Accordingly, the current study has proved the effectiveness of integrating brain gym technique with traditional learning in enhancing students' knowledge acquisition as well as knowledge retention maintenance.
- Educational training regarding on the brain gym for measuring the multiple intelligences score for teachers and students and train them to enhance their thinking skills.

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