serajiyan

Family and health Quarterly, vol12, Issu3, Autumn 2022, ISSN: 2322-3065

http://journals.iau-astara.ac.ir

Family and health

Comparison of Executive Functions and Spatial Somatosensory Ability in Normal Students and Students with Math Learning Disorders

Serajian Maralan H.,[1] Vahedi SH.,[2]* Chalabianloo GH.[3]

Abstract

Introduction: People with mathematical learning disorders have defects in information regulation, visual and auditory perception, memory and attention. Executive functions and visual-spatial ability are high-level cognitive actions that play the most important role in directing behavior, self-regulation, and academic preparation. The aim of the present study was to compare executive functions and spatial somatosensory ability in normal students and those with math learning disorders.

Research Method: The research method was causal-comparative. The statistical population of the research included all male students between the ages of 9 and 12 in Tabriz city in the academic year of 2022-2023. The research sample consisted of 120 students (63 normal students and 57 students with math learning disorders) who were selected by available sampling method. The research tools included Barclay's executive functions deficits questionnaire, and Carnoldi et al, visual spatial ability tests. Data were analyzed with SPSS-24 software and multivariate analysis of variance, t-test and one-way analysis of variance.

Findings: The results of the research showed that there is a significant difference between normal students and those with math learning disorders in executive functions ($P<0.001$) and spatial somatosensory ability ($P<0.05$).

Conclusion: As a result, normal students had better executive functions and spatial somatosensory ability. So, designing and implementing skill programs for executive functions and spatial somatosensory ability for students with math learning disorders seems necessary.

Keywords: executive functions, mathematical learning disorder, normal children, spatial somatosensory ability

Received: 3/October/2022 **Accepted: 12/December/2022**

Citation: Serajian Maralan H., Vahedi SH., Chalabianloo GH. Comparison of Executive Functions and Spatial Somatosensory Ability in Normal Students and Students with Math Learning Disorders, Family and health, 2022; 12(3): 154-170

[1] - Ph.D Student, Department of Psychology, Tabriz Branch, Islamic Azad University, Tabriz, Iran helenseraj61@gmail.com

[2] - Professor, Department of Educational Psychology, Faculty of Educational Sciences and Psychology, Tabriz University, Tabriz, Iran, corresponding author, serajiyan@yahoo.com

[3] - Associate Professor, Department of Psychology, Faculty of Educational Sciences and Psychology, Azarbaijan Shahid Madani University, Tabriz, Iran.

Introduction:

Children with learning disabilities are a group of exceptional children who have normal appearance and normal and sometimes higher intelligence. These children may have problems in several subjects or only in one subject (1) and in the face of successive academic failures, they gradually experience emotional disturbances and antisocial behaviors, which will lead to other problems (2). The United States Department of Education provided a definition of specific learning disability in the revised Individuals with Disabilities Education Act (IDEA). According to this law, the term children with learning disabilities refers to children who "have a disorder in one or more of the basic psychological processes such as comprehension, use of spoken and written language, and this disorder may manifest itself as an inability to hear, think, speak, read, write, spell, or perform mathematical calculations." These disorders include features such as cognitive disabilities, brain damage, mild brain disorders, dyslexia, and developmental (developmental) aphasia" (3). This definition does not include children who have learning problems due to visual, hearing or movement disabilities, mental retardation, emotional disorders or environmental, cultural or economic deprivations. (4). Learning disorders are classified into three main categories, which include "reading disorder, writing disorder, math disorder" (5). In math learning disorder, the student generally has deficiencies in three major skills, which are: (1) language skills (such as understanding and naming mathematical terms, understanding and naming mathematical actions and concepts and converting them into symbols); (2) perceptual skills (such as recognizing and reading numerical symbols or arithmetic signs and grouping figures) (6); (3) Mathematical skills (such as correctly copying numbers and memorizing numbers) (Ahadi and Kakavand, 2018). In general, children with math problems have problems in learning calculation processes and math applications (7).

The diagnosis of mathematical learning disorder is raised when the child's mathematical reasoning or calculation skills are significantly lower than expected for his age, intellectual ability and education level for at least 6 months, even with the presence of auxiliary interventions. To achieve mathematical skills, various skills are needed, which include: language skills, conceptual skills, and calculation skills (8). In the field of mathematical learning disorder, related challenges, cognitive processes and weakness in various skills have always been the focus of researchers. Executive functions can be mentioned among cognitive processes and skills.

Executive functions are a set of processes that are responsible for directing, guiding and managing cognitive, emotional and behavioral functions, especially during activities and solving new problems (9). Executive functions, as an integrated guiding system, regulate the control of actions, and spatial visual functions, memory, emotional experience, and motor skills serve to achieve a certain goal. In other words, executive function skills allow a person to understand stimuli from his environment, adaptive response, flexibility in changing direction, predicting future goals, considering consequences and responding in an integrated manner or correct judgment (10). Executive functions include: inhibition and control of stimuli, working memory, flexibility, cognition, planning and organization. Studies show that executive functions are self-regulating and any defect in the development of executive functions can lead to disruption in planning, memorization of tasks and memory (11). Also, a group of researchers have found out by examining the existing history that a set of factors cause the experience of difficulty and weakness in learning math skills to be so common. The first factor is the existence of several different components in mathematics (for example, calculation, geometry, problem solving) and the prerequisites for performing these tasks change depending on each of these different components (12). The second factor is that performing mathematical tasks requires the use of executive functions such as phonological (verbal) memory, working memory, visual-spatial skills, and knowledge about work methods (13). The findings of Ghasemi Tos et al.'s research (14) indicate that there is a significant difference between the executive functions of children with specific learning disorders and normal children. In another research, the findings indicate that specific learning disorder has a positive relationship with difficulty in executive functions, and the greater the severity of the disorder, the greater the difficulty in executive functions (15).

Learning is a step-by-step process that is based on the successful completion of learning tasks in order to acquire and collect knowledge. Children with working memory problems often fail in the classroom; Because the content load of working memory for each task is more than their capacity. When the working memory system fails, children forget what they were doing and this can lead to inattention. Finally, this leads to frequent loss of learning opportunities and as a result little academic progress (16). The strong relationship between working memory problems and a wide range of learning disabilities suggests that working memory should be evaluated whenever a child is referred with a possible learning disability.

Visual-spatial processing of working memory is one of the other important psychological variables in examining the areas of developmental insufficiency, including math learning disorder. Visual-spatial processing is a complex process that includes the student's ability to visualize objects mentally, the ability to recognize the difference between objects, orientation, left and right recognition, the ability to recognize relationships between objects in space (17). Visual-spatial perception is a process that is carried out in the right hemisphere of the brain and causes recognition of the state of objects and shapes in relation to each other, as well as relation to each other and relation to the observer. This skill helps the student in recognizing the sequence of letters and numbers in a word or the sequence of words in a sentence (18). Defects in visual-spatial skills can manifest themselves in mathematics in different ways (19); For example, the inability to interpret and use the spatial organization of presented mathematical materials (such as numbers in the decimal place, powers and geometric shapes), determining the location of numbers on the number axis, identifying figures and other mathematical symbols, written calculations, especially those in which spatial value is important (such as lending and transferring in calculations), controlling irrelevant visual-spatial information, visualizing and analyzing geometric shapes, interpreting diagrams, understanding and interpreting mathematical information presented in visual-spatial form. (like tables), memorizing and working with formulas (20).

Despite considerable evidence on the relationship between numerical and spatial mental representations, little attention has been paid to the role of visual-spatial memory in mathematics. At the same time, the evidences that exist in this field are not in agreement with each other. Studies have found evidence in support of the relationship between mathematical calculations and visual-spatial working memory performance. For example, Simmons, Willis and Adams (21) found in a study that in young children, visual-spatial working memory causes dispersion of judgments about symbolic values and suggested that it may be especially important in written plural problems. On the other hand, Noel, Desert, Abran and Seron reached the conclusion in their research that only the phonological similarity between numbers interferes with the individual's performance in addition problems; Therefore, they concluded that verbal working memory is more important than visual-spatial working memory in the storage of media information. Lomax and Haze-Wagon (22) also found a small role for visual-spatial working memory; That is, only when the information was presented visually. However, there are many reasons that visual-spatial working memory may play an important role in calculations. First, several studies have observed a relationship between math performance and spatial skills. Second, the semantic information in multi-digit numbers is encoded spatially (for example, the information about the position of the numbers, when dealing with numbers greater than 9). As a result, the relationship between visual-spatial memory and computation may be particularly important for multi-digit computing. Finally, research on the ways that adults and children represent and process numbers highlights the spatial nature of numerical representations (23).

Based on what was stated, research evidence indicates that visual-spatial skill is low in people with math learning disorder and its improvement is effective in solving the problems of math learning disorder (24). Also, in their research, Mahdavi Najmabadi, Kadivar, Arjamandania and Pushneh (25) emphasized the mediating role of working memory in visual spatial prediction based on mathematical self-efficacy. Keshavarz and Kakavand (26) concluded that mental retention ability, visual-spatial skill, and numerical processing speed are components that are more common in groups with math disorders. These weaknesses are not related to people's intelligence, which is related to failure in executive actions, specifically active memory; Therefore, it can be said that these components are among the distinguishing features of this group of students with special learning disabilities that should be paid special attention to when identifying and planning treatment. The review of research studies related to the field of disorders shows that executive functions and visual-spatial skills in children with attention deficit and autism have been considered; But these variables and their comparison have been neglected in the case of children with specific learning disorders, especially math disorders; Therefore, the present study was conducted with the aim of comparing executive functions and visual-spatial skills in normal children and children with math learning disorders.

Research method:

The design of the current research was descriptive and causal-comparative. The statistical population of this study consisted of all male students in the age range of 9 to 12 years in the academic year of 1402-1401 in Tabriz. Using available sampling, 120 people (63 normal students and 57 students with math learning disorders) were selected. The entry criteria for students with a satisfactory disorder include: 1) having a math learning disorder with a score of less than 58 as a cutoff point in the KIMAT test, 2) a diagnostic interview for a learning disorder based on DSM-V; 3) having a low score (less than 95) in the general intelligence of the Wechsler test; 4) completion of the written consent form by the parents and the child's desire to participate in the study; 5) not having obvious physical and mental disability or illness; 6) Non-participation of the child in the special training course was selected. Then normal students who were equal to this group of students in other conditions except special learning disorder were selected to compare the variables. In order to collect data, the following tools were used:

Barkley's Questionnaire of Executive Function Deficits of Students and Adolescents: The long form of the Questionnaire of Executive Function Deficits of Children and Adolescents was designed by Barkley (27) with the aim of representing executive functions in non-clinical and clinical populations, especially children and adolescents. The said scale includes 70 items, which are graded based on a 4-point Likert scale from never (=1) to always (=4). This tool includes five subscales, which measure the executive functions of time self-regulation (13 questions), organization and problem solving (14 questions), self-control and inhibition (12 questions), self-motivation (14 questions), and self-regulation of emotion (16 questions). Scores between 70 and 140 indicate low executive functioning impairment, scores between 140 and 175 indicate moderate executive functioning impairment and scores above 175 indicate strong executive functioning impairment (Barclay, 2012). The validity of the total scale with Cronbach's alpha of 0.99 and subtypes of 0.74 to 0.33 has been reported by Barkley (27). Soltani et al. (28) conducted a research with the aim of determining the validity and reliability of Barclay students' and adolescents' executive functions questionnaire. The results showed that the questionnaire has good reliability and validity in Iranian society and can be used in various fields of research in Iran. In the research of Mohabbate Bahar et al. (29), the alpha coefficients for the whole scale of executive functions and the sub-components of time self-management, self-organization/problem solving, self-control/inhibition, self-motivation and emotional self-discipline are equal to 0.90, 0.85, 0.82, 0.78, 0.76 and 0.72, respectively, which indicate the reliability of the executive functions questionnaire. The validity results of the test in all subscales were reported as 0.79.

Visual-spatial test: The visual-spatial working memory test was designed by Carnoldi, Rigonio Trischoldi (30) and is known as the working memory matrix. In this test, a 3 x 3 matrix is used in which only the left square of the lower part is red. The red square is considered as the starting point. Subjects were asked to look at the matrix carefully and keep it in their memory. Then they are told to listen carefully to the commands given by the examiner in the form of left, right, down, and up, and based on that, move the red house inside the matrix, and at the end of the commands that require movement in the matrix, show the house where the red house is now moved to. This test is performed three times and each time consists of 6 commands. The score of each subject is calculated based on success in these steps. 1 point is considered for each successful step. In total, the subject can score from 0 to 3. The reliability coefficient of the test based on Cronbach's alpha method was obtained by Karnoldi and Veggia (31) as 0.78. Also, the reliability of this test with the test-retest method for children aged 4.5 to 11.5 has been reported as 0.83. In Keshavarz and Kakavand's research (26), the validity of this test was obtained using Cronbach's alpha coefficient of 0.79.

After determining the number of samples, with permission from Tabriz Department of Education, the said schools were visited and the necessary information was given to the students regarding the questionnaires, the objectives of the research and how to answer the questions, and finally the questionnaires were provided to the students. In order to ensure the confidentiality of the students' information, their details were coded. After collecting information, SPSS-24 software and descriptive and inferential statistics, Wilks's lambda test, multivariate analysis of variance, and one-way analysis of variance test were used to analyze the data.

Findings:

The mean and standard deviation of the scores of normal children and those with math learning disorders in variables of executive function and visuospatial skill are shown in table (1).

Table 1. Mean and standard deviation of executive function defects and visual-spatial skills of people

Variable	Group	Mean	SD
Self-regulation of time	Disorder group	33.80	3.002
	normal group	28.20	3.48
	total score	31.3	3.241
Organization and problem solving	Disorder group	33.95	4.718
	normal group	26.90	6.26
	total score	30.415	5.517
Self-control and inhibition	Disorder group	32.85	5.733
	normal group	25.30	4.42
	total score	29.085	5.076
Self-motivation	Disorder group	38.55	4.968
	normal group	30.01	4.449
	total score	34.25	4.712
Emotional self-regulation	Disorder group	49.25	4.723
	normal group	39.05	3.203
	total score	44.18	3.971
Impairment of executive functions (total)	Disorder group	188.4	23.144
	normal group	149.55	22.58
	total score	169.23	22.871
Visual-spatial skill	Disorder group	1.05	0.686
	normal group	1.55	0.759
	total score	1.32	0.724

In order to investigate the first hypothesis of the research, due to the fact that the variable of executive functions has five components, multivariate variance analysis was used. In order to choose the appropriate statistical tests for the analysis of the collected data, it is necessary to evaluate the type of distribution of the variables in terms of the normality of their distribution.

Also, to check the assumption of homogeneity of variances in the studied groups, which is another assumption of variance analysis, Lon's test was used, the results of which are given in table (2).

Table 2. Results of Kolmogorov-Smirnov test and homogeneity of variance by groups

Variable	**Normal group**		**Disorder group**		**Homogeneity of variance**	
Self-regulation of time	K-S statistic	Sig	K-S statistic	Sig	Loon statistics	Sig
Organization and problem solving	0.86	0.44	0.67	0.76	2.72	0.12
Self-control and inhibition	0.66	0.76	0.70	0.71	1.32	0.23
Self-motivation	0.74	0.63	1.189	0.11	1.08	0.30
Emotional self-regulation	0.79	0.55	0.86	0.44	2.61	0.15
Impairment of executive functions (total)	0.89	0.40	0.64	0.79	1.14	0.41
Visual-spatial skill	0.92	0.51	0.81	0.63	3.28	0.76

Based on the results listed in table (2), the distribution of scores of components of executive functions and visual skill in two groups is not significant at the 0.05 level; Therefore, with 95% confidence, we can conclude that the distribution of scores in all variables in two groups of normal and disordered students is normal. As a result, the parametric tests used for the desired variables in this research are appropriate. Based on table (2), the results of Lon's test are given to check the homogeneity of variances. According to the results listed in the table, the similarity of the variances of the two groups in the scores of executive functions and its components and visuospatial skill is not significant at the 95% level. In other words, considering that the non-significance of Lon's test means confirming the null hypothesis, it can be concluded with 95% confidence that the variances of the two groups of normal and impaired students in the scores of the two variables are the same. After establishing the assumptions of normality and homogeneity, multivariate analysis of variance was used to compare the executive functions and its components between the two groups.

Table 3. Results of multivariate analysis of variance

Effect	**Tests**	**Value**	**F**	**Degree of freedom effect**	**Error degree of freedom**	**Sig**
	Pillai effect	0.248	16.099	5	114	0.001
Group	Wilks Lambda	0.752	16.099	5	114	0.001

	Hoteling's work	0.330	16.099	5	114	0.001
	The largest Roy root	0.330	16.099	5	114	0.001

As Table (3) shows, the obtained F ratio is significant at the level ($P<0.05$). As a result, the groups have a significant difference in at least one of the dependent variables (executive functions and its components). But this statistic does not show which of the dependent variables has a significant difference. Therefore, after that, it was investigated that each of the components of executive functions, including emotional self-regulation, organization and problem solving, self-control and inhibition, self-motivation and emotional self-regulation, and the total score were affected separately by the independent variable (groups). In the following table (4) the result of the analysis of variance between subjects is given.

Table 4. Results of multivariate analysis of variance between subjects

Source of changes	**The dependent variable**	**sum of squares**	**Degrees of freedom**	**mean square**	**F**	**Sig**
Group	Self-regulation of time	0.04	10.98	557.78	1	557.78
	Organization and problem solving	0.037	12.04	502.455	1	502.455
	Self-control and inhibition	0.001	28.06	397.321	1	397.321
	Self-motivation	0.001	40.053	242.23	1	242.23
	Emotional self-regulation	0.001	38.065	435.125	1	435.125
	Impairment of executive functions (total)	0.001	60,726	6797.78	1	6797.78
Error	Self-regulation of time	33.640	117	3935.900		
	Organization and problem solving	22.337	117	2613.510		

	Self-control and inhibition	18.562	117	2171.761
	Self-motivation	8.344	117	976.320
	Emotional self-regulation	18.384	117	2151.030
	Impairment of executive functions (total)	189.441	117	22164.400

As can be seen in table (4), the result of the multivariate analysis of variance for the components of time self-regulation and organization and problem solving between groups was significant at the P<0.05 level, and for the other components, it is significant at the level of less than 0.001; Therefore, the hypothesis of the existence of a significant difference between the scores of executive functions of two groups of normal students and those with mathematical learning disorders is confirmed. In order to investigate the next hypothesis of the research, considering that the visual-spatial skill variable does not have a component, t-test and one-way analysis of variance (ANOVA) between groups were used. For this purpose, the t-test was first performed.

Table 5. The results of the t-test and checking the homogeneity of variance

Variable	**Leon statics**	**Sig**	**Degree of freedom 1**	**Degree of freedom 2**	**t**	**Sig**
Visual-spatial skill	0.04	0.95	1	118	4.089	0.001

According to the results of table (5), the t value of 4.089 is at a significant level of less than 0.001 outside the range of +2.58 and -2.58; Therefore, there is a difference between the two groups in terms of visual-spatial skills. Considering that the value of Lon's statistic is at a significant level of more than 0.05, therefore, the hypothesis of homogeneity is established and one-way analysis of variance test can be used.

Table 6. Results of variance analysis of visual-spatial skill variable

Visual-spatial skill	**Sum of mean**	**Degree of freedom**	**mean square**	**F**	**Sig**
between groups	392.217	1	392.217	5.304	0.001
Intergroup	8724.834	118	73.939		
Total	9117.051	119			

As can be seen in table (6), the result of the one-way analysis of variance between groups for the visual-spatial skill variable ($F=5.304$) is significant between the groups at the $P < 0.01$ level, so the research hypothesis is confirmed and there is a significant difference between the two groups of normal students and those with math learning disorders.

Discussion and conclusion:

The purpose of this research was to determine the difference between executive functions and visual-spatial skills between normal students and students with math learning disorders. The obtained results showed that the executive functions and its components are significantly different between the two groups. This finding was in line with the study of Ghasemi Tous et al. (14). Executive functions are skills that help a person to decide what kind of activities or goals should be considered, which ones to choose, and how to organize and plan behaviors. The existence of defects in visual perception and working memory in children with learning disabilities, especially math disorders, is the main reason for their problems; Because usually such students have a disorder in processing skills; Visual information is used to examine and understand the shape as well as visual symbols such as letters and numbers, which is the basis of word recognition and mathematical operations based on these skills (32). These skills are so important that weakness and some kind of disorder in them causes learning problems. Considering the importance of executive functions and several theories that have been proposed in this field, researchers consider the empowerment of these functions to be effective. Reynolds and Horton believe that executive functions are different from general knowledge. They suggested that executive functions represent the capacity to plan, do things, and implement adaptive actions, while the task of general knowledge is to preserve and maintain a set of organized objective facts. On the other hand, children who perform mathematical tasks use methods for mental representations of numbers that rely on executive functions. For example, Hoggs has come to the conclusion that young children can answer questions better when simple addition and subtraction problems are presented in the form of tangible and concrete situations than when they are presented in the form of abstract numbers. Holmes and Adams have also supported this idea and suggested that executive functions may provide a mental working space for the child, which allows him to represent abstract problems in an objective way and with more manipulability in his mind.

The ability to plan and organize as one of the most important executive functions and excellent activities of the brain, both in terms of having a role in performing daily life activities and in terms of its role in coordinating other functions to achieve the goal, has been the focus of various researchers. Lezak, Howison and Loring (34) consider this executive function as the ability to identify and organize the steps and elements required to carry out an intention or achieve a goal. Since the ability to plan and organize is part of the high functions of the prefrontal cortex, it is believed that the damage or disorder in the prefrontal areas and some areas of the subcortex of the brain is significantly related to the student's ability to plan and organize.

In addition, flexibility means the ability to present knowledge in multiple conceptual forms, from different perspectives, and then the ability to apply them based on the same conceptual and form diversity in order to understand or solve problems and create new knowledge. When learners clearly observe how knowledge is transferred in the form of a valid thematic synthesis within different content areas, they apply that knowledge in multiple areas. New theories look at flexibility as a multidimensional structure that includes fundamental variables such as temperament, personality and specific skills such as problem solving skills. These skills allow a person to make a favorable adaptation to traumatic or traumatic life events; Therefore, although the first wave of research in the field of flexibility focused more on understanding the characteristics of flexible people; But the second wave was based on understanding the processes through which people could successfully show positive adaptation to stress and traumatic events (34). Finally, processing speed can be considered as the speed and ability of a person to perform simple cognitive tasks. D'Amico and Pasolonghi (35) found in a research that fourth grade students who had math learning problems had poor performance in terms of speed of activation of numerical and non-numerical information from working memory. Fachs and colleagues (36) also found in a research that processing speed is an important predictive factor of calculation ability, which is measured by tasks including the rules of addition and subtraction of numbers. However, processing speed and working/short-term memory are two separate systems (37).

Another finding of the research showed that there is a difference between normal students and students with math learning disorders in visual-spatial skills of working memory. In checking the alignment of this result with previous studies, Bishara's study (38) and Dergas, Mitsia and Skins (39) showed that children who have problems in mathematics; They usually have problems with spatial perception. For example, they get confused in understanding the concepts of up, down, left, right, below, back and front, etc., and these problems create a disturbance in the mental image of the number system and cause these children to not be able to recognize the distance between the numbers and their respective places. The cause of disability in visual-spatial skill for students with math learning disorder is caused by damage to the parietal lip (40); In addition to visual-spatial ability, damage to the parietal lobe also disrupts short-term memory and working memory, and left temporal-parietal damage seriously disrupts the ability to recall number sequences (41) and these areas mainly play a role in maintaining verbal materials, and the right temporal-parietal areas play a role in maintaining non-verbal materials such as spatial status. Researches have also attributed a complementary role to the temporal and temporal parts in memory (4). Research evidence shows that working memory performance is a source of information that can differentiate between students with learning disabilities and those who are slow learners. Of course, working memory scores alone are not enough for diagnosis, other assessment information should also be considered. In addition, it should be taken into account that there are often several causal factors for learning disorders and the profile of cognitive processing of people is different. Working memory deficits are rarely the only deficits found in people with learning disabilities. For example, individuals with a basic impairment in reading skills may also have concurrent deficits in phonological processing or long-term memory. People with lower overall cognitive ability may also have poor working memory. What distinguishes people with learning disorders is that working memory problems are only one of their defects (42).

Some researchers believe that inherent limitations of working memory are the primary cause of learning disorders. Nevertheless, since many of the researches conducted on working memory and learning disorders are correlational, it is not possible to infer causation from them. An alternative explanation is that working memory deficits are the result of failure in learning, rather than the primary cause (43). Some specialists also claim that working memory problems are secondary to other cognitive processing problems. Such discussions are in line with McDonald's and Christensen's point of view, who believe that working memory is a sub-skill among different cognitive domains, such as language. Researches also indicate the role of the frontal lobe in the use of memory (44). In a research, Patel et al showed that the temporal and parietal regions are more active in the auditory working memory test in dyslexics. A low score in calculating and reading numbers is a reflection of poor attention or sequence (45). Computational neuroscience provides a mathematical framework to facilitate the study of mechanisms involved in brain function, including visual attention, memory, and behavior control by rewarding mechanisms. Also, it helps to analyze and analyze neuronal networks at each neuron level, compound and explosive, and also to many aspects of brain function, from the activities of individual neurons to the effects of medicinal agents in the synapse and tissue flow. Neural nodes that help to integrate many aspects of visual recognition and attention functions that are understandable and can be modeled (46). This approach describes explicit and clear predictions at all levels that can be tested. In this theory, the expansion and improvement of understanding is one of its basic and dynamic processes. This type of basic analysis and analysis helps humans to have a deep understanding of neuroscience and how the brain performs complex tasks (46). On the other hand, children encountering uncontrollable events such as reducing cognitive activities such as reducing working memory capacity and visual-spatial skills, disrupting attention and inhibiting information processing, and reduces the individual's motivation to make new hypotheses to solve the problem. Also, the problems that children with learning disorders have in visual-spatial skills lead to the poor performance of these children in mathematics lessons, and this continuous and successive lack of success in these children causes the growth of their negative feelings and attitudes towards this lesson (47); Therefore, teachers and those involved in education can indirectly reduce and finally eliminate the negative attitude towards mathematics by creating solutions to strengthen various executive functions, including neuropsychological interventions. Not being under the control of educational and cultural factors affecting executive functions and visual-spatial skills was one of the limitations of the present study. It is suggested that other factors and variables affecting executive functions and visual-spatial skills should be researched in relation to these structures.

References:

1- Jahian Najafabadi A., Imani H., Jabari R.. The effect of direct electrical stimulation of the brain from the skull (tDCS) on children with learning disabilities. Principles of Mental Health, 2019; 9(4): 10-21

2- Pinel J. Physiological psychology. Translated by Firozbakht, Mehrdad. Publishing edits. Shokohi Yekta M., and Parand A. Learning disabilities. Tehran: Taimurzadeh Publishing; 2019

3- Shokohi Yekta M., Parand A. Learning disabilities. Tehran: Taimurzadeh Publishing; 2019

4- Fletcher J.M., Lyon G.R., and Fuchs L.S., Barnes M.A. Learning disabilities: From identification to intervention. Guilford Publications; 2018

5- Hall T.E. Hughes C.A. Filbert M. Computer assisted instruction in reading for student with learning disabilities: a research synthesis. Education and Treatment Children, 2015; 32: 173-193, https://doi.org/10.1177/016264341002500401

6- American psychiatric Association. Diagnostic and statistical Manual Disorders**.** DSM -Fifth Edition, 2017

7- McDowell, M. Specific learning disability. Journal of pediatrics and child health, 2018; 54(10): 1077-1083, **https://doi.org/10.1111/jpc.14168**

8- Sadock J., Sadock V.A., Ruiz P. Kaplan and Sadok's Summary of Psychiatry Behavioral Sciences/Clinical Psychiatry. The third volume of the 11th edition of 2015. Honorable publication. PMCID: PMC2802389.

9- Goldstein S., Naglieri J.A. Executive functioning. A Goldstein, Sam; 2014

10- Mirzakhani, Navid; Porjabar, Nasim; Rezaei, Mehdi; Dibajnia, Parveen and Akbarzadeh Baghban, Alireza (2015). Investigating the effect of structured game on the executive performance of high-functioning autistic students 5-12 years old. Bimonthly scientific-research journal of rehabilitation medicine, 5(3), 35-47. https://sid.ir/paper/239722/fa [in Persian]

11- Yaghoubi H., Waqif L., and Ebadi M. Examining executive functions in students with learning disabilities, the third national conference on strategies for the development and promotion of educational sciences of psychology, counseling and education in Iran; 2015

12- Ahadi Hassan Kakavand A. Learning disorders (from theory to practice) along with practical solutions to solve common academic and learning problems. Arsbaran publication; 2018

13- Grigorenko EL, Compton DL, Fuchs LS, Wagner RK, Willcutt EG, Fletcher JM. Understanding, educating, and supporting children with specific learning disabilities: 50 years of science and practice. Am Psychol. 2020 Jan; 75(1):37-51. doi: 10.1037/amp0000452. Epub 2019 May 13. PMID: 31081650; PMCID: PMC6851403.

14- Ghasemi Tous M., Soltani Kohbanani S., Karsheki H., and Tatar F.. Comparison of cognitive flexibility, problem solving, verbal fluency, working memory, reasoning and response inhibition in students with math disorders. Disability Studies,2021: 38 D.o.r: 20.1001.1.23222840.1399.10.0.38.7 [in Persian]

15- Erostarbe-Pérez M., Reparaz-Abaitua C., Martínez-Pérez L., Magallón-Recalde S. Executive functions and their relationship with intellectual capacity and age in schoolchildren with intellectual disability. Journal of Intellectual Disability Research, 2022; 66(1-2): 50-67. PMID: **34542219**, DOI: 10.1111/jir.12885

16- Gathercole S.E., Alloway T.P., Kirkwood H.J., Elliot J.G., Holmes J., Hilton K.A. Attentional and executive function behaviors of children with poor working memory.

Learning and individual differences, 2008; 18: 214-223, https://doi.org/10.1016/j.lindif.2007.10.003

17- Abedi A. The effect of neuropsychological interventions on improving the academic performance of students with learning disabilities. Cognitive Science News, 2014; 12(1): 1-6. URL: http://icssjournal.ir/article-1-173-fa.html

18- Rainey W. Development and strengthening of perceptual-motor skills in children. Translated by Sazmand, Ali and Tabatabai, Mehdi. Tehran: Danje; 2016 [in Persian]

19- Haerifar A, Soltani A, Kamyabi M, Manzari Tavakoli H. The Effects of Strengthening Motor-sensory Functions on Spatial Visual Processing and Balance Function in Preschool Children with Developmental Coordination Disorder. MEJDS 2021; 11 :167-167, URL: http://jdisabilstud.org/article-1-2634-fa.html

20- Mammarella I.C., Lucangeli D., Cornoldi C. Spatial working memory and arithmetic deficits in children with nonverbal learning difficulties. Journal of Learning Disabilities, 2010; 43(5): 455–468. https://doi.org/10.1177/0022219409355482

21- Simmons FR, Willis C, Adams AM. Different components of working memory have different relationships with different mathematical skills. J Exp Child Psychol. 2012 Feb; 111(2):139-55. doi: 10.1016/j.jecp.2011.08.011. Epub 2011 Oct 20. PMID: 22018889.

22- Lomax R.G. Hahs-Vaughn D.L. Statistical concepts. New York: Routledge; 2012

23- De Hevia MD, Vallar G, Girelli L. Visualizing numbers in the mind's eye: the role of visuo-spatial processes in numerical abilities. Neurosci Biobehav Rev. 2008 Oct; 32(8):1361-72. doi: 10.1016/j.neubiorev.2008.05.015. Epub 2008 May 20. PMID: 18584868.

24- Ghazizadeh M. The functional role of working memory, visual-spatial and processing speed in predicting the academic performance of children with special mathematical learning disorder. Learning Disabilities, 2022; 12(1): 73-84. doi:10.22098/jld.2022.11113.2029

25- Mahdavi najmabadi Z, kadivar P, Arjmandnia A A, Poushaneh K. The mediating role of working memory and mathematical anxiety in predicting spatial visual processing based on mathematical self-efficacy and creativity. Journal of Psychological Science. 2021; 20(98): 269-282. URL: http://psychologicalscience.ir/article-1-802-fa.html

26- Keshavarz S, Kakavand A. Study of Numerical Processing Speed, Implicit and Explicit Memory, Active and Passive Memory, Conservation Abilities, and Visual-Spatial Skills of Students with Dyscalculia . J Child Ment Health 2019; 6 (2) :53-67 URL: http://childmentalhealth.ir/article-1-730-fa.html

27- Barkley R.A. Barkley Deficits in Executive functioning scale children and adolescents (BDEFS-CA**)**. NEW York: Guilford Press; 2012

28- Soltani Kohbanani S., Zarenejad S., Soltani Kohbanani M.H., Bazari K.. Examining the psychometric characteristics of Barkley's executive function deficits questionnaire for children and adolescents. Psychology of exceptional people, 2017; 8(30): 19-45. doi:10.22054/jpe.2018.9209

29- Mohabbat Bahar S, Moradi Jo M, Raigani S.M, Mashhadi A, Bigdali I.E. Effectiveness of repeated brain magnetic stimulation on working memory of patients with treatment-resistant major depressive disorder. Research in medicine [Internet]. 2016; 41(2):77-85. Available from: https://sid.ir/paper/41613/fa
30- Cornoldi C, Rigoni F, Tressoldi PE, Vio C. Imagery deficits in nonverbal learning disabilities. J Learn Disabil. 1999 Jan-Feb; 32(1):48-57. Doi: 10.1177/002221949903200105. PMID: 15499887.
31- Cornoldi C, Rigoni F, Tressoldi PE, Vio C. Imagery deficits in nonverbal learning disabilities. J Learn Disabil. 1999 Jan-Feb; 32(1):48-57. doi: 10.1177/002221949903200105. PMID: 15499887.
32- Bagharpour Styar N., Habibi Kaliber R., Misrabadi J. Effectiveness of training neuro-psychological executive functions on extra memory, planning and problem solving of students with math disorder. Cognitive psychology [Internet]. 2018; 7(4):63-79. Available from: https://sid.ir/paper/527010/fa
33- Lezak M.D., Howieson D.B., Loring D.W. Neuropsychological Assessment (fourth Eds). New York: Oxford University Press; 2004
34- Campbell J., Cercignani M., Langdon D., Rashid W. Cognitive Rehabilitation In Multiple Sclerosis; 2015, https://www.researchgate.net/publication/312324078.
35- D´Amico A. Guarnera M. Exploring working memory in children with low arithmetical achievement. Learning & Individual Differences, 2015; 15: 189-202. DOI:10.1016/j.lindif.2005.01.002
36- Fletcher J.M., Lyon G.R., Fuchs L.S., Barnes M.A. Learning disabilities: From identification to intervention. Guilford Publications; 2018
37- Kail RV. Longitudinal evidence that increases in processing speed and working memory enhance children's reasoning. Psychol Sci. 2007 Apr;18(4):312-3. doi: 10.1111/j.1467-9280.2007.01895.x. PMID: 17470254.
38- Bishara S., Wubbena Z. (Reviewing Editor). Active and traditional teaching, self-image, and motivation in learning math among pupils with learning disabilities, Cogent Education, 2018; 5(1): DOI: 10.1080/2331186X.2018.1436123
39- Drigas A., Mitsea E., Skianis C. Virtual Reality and Metacognition Training Techniques for Learning Disabilities. Sustainability, 2022; 14(16): 10170 . DOI:10.3390/su141610170
40- Grigorenko EL, Compton DL, Fuchs LS, Wagner RK, Willcutt EG, Fletcher JM. Understanding, educating, and supporting children with specific learning disabilities: 50 years of science and practice. Am Psychol. 2020 Jan; 75(1):37-51. doi: 10.1037/amp0000452. Epub 2019 May 13. PMID: 31081650; PMCID: PMC6851403.
41- Muhammad Sofwan M., Mohd Syazwan Zainal, Roslinda Rosli, Siti Mistima Maat, and Dyscalculia: What We Must Know about Students' Learning Disability in Mathematics? Universal Journal of Educational Research, 2020; 8(12B): 8214-8222, 2020. DOI: 10.13189/ujer.2020.082625.

42- Dehaene S. The neural basis of the Weber-Fechner law: a logarithmic mental number line. Trends Cogn Sci. 2003 Apr; 7(4):145-147. doi: 10.1016/s1364-6613(03)00055-x. PMID: 12691758.
43- Torgesen J.K. Learning disabilities as a working memory deficit: The important next questions. Issues in Education, 2001; 7: 93–102.
44- Horowitz T.S., Treviño M., Zhu X., Lu Y.Y., Huang G.C., Germine L.T. How do we measure attention? Visual cognition meets neuropsychology. Journal of Vision, 2020; 20(11): 537-537 doi:https://doi.org/10.1167/jov.20.11.537 .
45- Patael S.Z., Farris E.A., Black J.M., Hancock R., Gabrieli J.D., Cutting L.E., Hoeft F. Brain basis of cognitive resilience: Prefrontal cortex predicts better reading comprehension in relation to decoding. PloS one, 2018; 13(6): e0198791 . https://doi.org/10.1371/journal.pone.0198791
46- Tandon M, Pergjika A. Attention Deficit Hyperactivity Disorder in Preschool-Age Children. Child Adolesc Psychiatr Clin N Am. 2017 Jul; 26(3):523-538. doi: 10.1016/j.chc.2017.02.007. PMID: 28577607.
47- Ciccone AB, Deckert JA, Schlabs CR, Tilden MJ, Herda TJ, Gallagher PM, Weir JP. Transcranial Direct Current Stimulation of the Temporal Lobe Does Not Affect High-Intensity Work Capacity. J Strength Cond Res. 2019 Aug; 33(8):2074-2086. doi: 10.1519/JSC.0000000000002561. PMID: 29489734.
48-