

## The Comparison of Quadruple Brain Processing skill training Effectiveness on Cognitive Functions in Students Experiencing Learning Impairment in Mathematics and Reading

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### Abstract

**Introduction:** Given that there is a significant and negative relationship between the mathematics operation and lack of concentration, hyperactivity and impulsivity, there is a positive relationship between learning strategies, attitude towards study and self-concept as well; the present study was carried out to determine the effectiveness of quadruple brain processing skill training on cognitive function in the students experiencing learning disorder in math and reading.

**Method:** The current study was practical and applicable in terms of purpose, and in terms of data collection was semi-experimental, pretest-posttest type along with control group and follow-up after two months. The statistical population includes all the students who were introduced to Tehran special center of learning disorders, in the second primary school grade, experiencing math learning disorder, in 4<sup>th</sup>, 5<sup>th</sup> and 6<sup>th</sup> grades in Tehran during school year, 2018-2019. Purposive sampling method was used for sampling. 30 students were selected as the experimental group and performing interventions, and 30 were chosen as the control group. 10-session training meetings were held for the subjects of the experimental group. Research tools were Children's Wechsler Test, Cas test and holding training course for experimental group. Kolmogorov Smirnov, Mauchly's Sphericity test, Levene's test for equality of error variance, two-way analysis of variance, Bonferroni post hoc test, and bar graph were used to analyze data.

**Findings:** there is no significant difference in the effectiveness of quadruple brain processing skill training on cognitive function in the students experiencing learning disorder in math and reading. But, quadruple brain processing in the experimental group leads to a significant increase in their pretest score of cognitive functions the mean of experimental groups was 281.729 and the control groups equals (263.321).

**Conclusion:** the results indicate that quadruple brain processing skill training is effective on the cognitive functions in the student's experiencing math and reading learning disorders.

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## Introduction:

Learning disabilities are neurobiological impairments which affect the basic processes of verbal and written language understanding. Students suffer from learning disorders are unable to solve problems and they are not usually aware of problem-solving processes (1). It is estimated that 10% of students have some form of learning disorders and on average, two/three students in each class have learning disorders (2). According to Fletcher's definition, students experiencing learning disabilities, cannot be successful in various educational skills such as listening, comprehensive reading, basic reading skills, mathematical calculations and problem solving according to their age and assessment levels standards (score) (3). Difficulty in counting, comparing quantities, recognizing numbers and digits and working memory are considered, by the researchers, as the reliable indicators in early diagnosis of mathematical learning disabilities in children. Epidemiological study has shown that between 5-10% of school children are suffering from mathematical learning disabilities, and in etiology, this impairment has referred to a combination of nature and nurture impact (4). A study review indicates that students' educational performance is influenced by cognitive functions (5,6). Cognitive functions help the development of children's abilities (7) and accompanied with educational success (8).

The quadruple brain processing is among the effective models in this field which has four basic cognitive functions, according to Pass theory<sup>5</sup> as a cognitive processing theory rooted in Luria's neuropsychological conceptualization of cognitive processes, i.e., planning, concentration, parallel processing, and chain processing, also it has close relationship with person's performance in cognitive (functions) processes. As it is a multidimensional process, reflects the interconnected actions of various areas in brain (9), and according to Luria's belief, the integration of cognitive processing is vital to understand the brain function (10). Especially, recent studies provided that the function of PASS theory and cognitive functions suggested some helpful recommendations in learning disorders field (11,12). Basically, Luria has associated the PASS theory with three functional units of the brain. Considering first structural unit means it is related to the brainstem and mesencephalon (midbrain) . Parallel and chain processing are grafted to the second structural

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<sup>5</sup> Planning, Attention, Successive & Simultaneous (PASS)

unit means occipital, temporal and parietal lobes. Planning is grafted to the third structural unit means frontal lobe; especially frontal lobe grafted in the same direction (13).

Reading and math are among the subjects in which their appropriate function was and are always very important to the students and their parents. Considering that the main task of neurological goal-oriented processes in cognitive functions is controlling and coordinating behavior, these functions help individuals in different fields including planning goals, monitoring own behavior, avoiding inappropriate responses, flexibility and future behavior orientation (14). Das and Misra's (15) study have reported, according to the PASS theory function, concentration, attention and especially parallel processing are corresponding to the problem solving. Cai (16) considered planning as important in doing numerical tasks and memorizing basic mathematical facts, as well. Naglieri (17) has also linked planning with mathematical general success. Other studies results support the role of working memory, attention, and phonological awareness in learning reading and mathematical skills (18). Siavashifer (19) has carried out research with the aim of comparing the effectiveness of Dawsonguier program and training of metacognitive strategies on executive functions (attention, working memory and behavioral inhibition) in the students experiencing learning disabilities with reading characteristics. Findings have shown that both interventional programs have significant effect on improving attention, working memory and students' behavioral inhibition who suffer from learning disorder with reading characteristics. Khanjani (20) investigated the effectiveness of the cognitive rehabilitation therapy in improving children's visual and auditory memory experiencing learning disorder with/without attention deficit-hyperactivity impairment. The present study findings indicated that cognitive rehabilitation method is effective for the aforementioned groups and the difference in effectiveness of auditory memory was significant in two groups. Child (18) conducted a survey on the examination of the relationship between reading and mathematics with regard to phonological awareness, working memory and processing speed. The results have shown working memory, attention and phonological awareness play important roles in learning reading and mathematical skills. Vicente (21) in his research examined this question that how related variables with cognitive functions and learning and mathematical improvements are related to each other among the primary school children. The results have shown that there is a negative and significant relationship between mathematics operation and lack of attention, hyperactivity and impulsivity, as well as positive relationship between learning strategies, attitude towards study and self-concept. Therefore, the main hypothesis of the present study is as follows: "Is there a difference between quadruple brain processing skill training on cognitive functions in two groups of students experiencing math and learning disorders?"

### **Method:**

The current study was practical and applicable in terms of purpose, and in terms of data collection was semi-experimental, pretest-posttest along with control group and follow-up after two months. This plan is formed by adding pretest to posttest plan to the control group. The statistical

population includes all the students who were introduced to Tehran special center of learning disorders, in the second primary school grade, experiencing math learning disorder, in 4<sup>th</sup>, 5<sup>th</sup> and 6<sup>th</sup> grades in Tehran during school year, 2018-2019. Purposive sampling method was used for sampling. Four centers among the special learning disorders center in Tehran were selected for choosing the subjects. 30 students were selected as the experimental group and performing interventions, and 30 were chosen as the control group. 10-session training meetings were held for the subjects of the experimental group. After finishing training sessions (which are thoroughly describes as follows), the research questionnaires were conducted on both experimental and control group as a posttest. The following standard test was used for collecting data:

**Wechsler Intelligence Scale for Children:** it contains 16 sub-tests to evaluate their cognitive abilities and children's intelligence aged 6-16 years and 11 months which were provided, adapted and standardized by the psychometric institute in 2014. This test contains 16 sub-tests.

**CAS Test:** according to the examination of "cognitive evaluation system known as CAS test", the evaluation and assessment of training in both experimental groups 1&2 PASS theory was designed and provided. CAS test is an individual performance test which is designed for 5-17 years old children and adolescents. It contains 12 sub-tests which all are usually implemented and organized according to the 4 PASS areas. Meanwhile, an overall score is considered and calculated for the entire scale. PASS subscales and standard scores of entire scale can be obtained through using two combinations of subtests and in two forms. 10-sessions meetings were hold as the training session for the subjects of experimental group. Kolmogorov Smirnov, Mauchly's Sphericity test, Levene's test for equality of error variance, two-way analysis of variance, Bonferroni post hoc test, and bar graph were used to analyze data as the statistical methods.

### **Findings:**

To examine the effectiveness of quadruple brain processing skill training on the students' cognitive functions, who suffer from math and reading learning disorders to respond this hypothesis, two-way ANOVA was used respecting the assumptions (normality, variance homogeneity and regression line slope homogeneity between groups), due to the presence of a continuous dependent variable (cognitive function posttest score) and a covariate (cognitive functions pretest score), a skill training stratified independent variable in two levels (experimental and control groups) and an impairment stratifies independent variable in two levels (students experiencing math learning disorder and students experiencing reading learning disorder).

**Table 1.** The homogeneity of the regression slope lines (mutual effect test)

variables	<u>SS</u>	<u>df</u>	<u>MS</u>	<u>F</u>	<u>sig</u>
Mutual effect of pretest score in skill training	.065	1	.065	.003	.960
Mutual effect of pretest score in some forms of impairments	2.324	1	2.324	.090	.766
Mutual effect of pretest score in skill training and some forms of impairments	8.788	1	8.788	.340	.564
error	853.005	33	25.849		

Symbols: df= degree of freedom, SS= sum of squares, MS= mean squares, F=test, sig= statistical significance

According to the results, statistical significance was more than 0.05 for all three F-statistics; mutual effect non-significance showed the data supports the hypothesis of the homogeneity of the regression slope lines, therefore, the assumptions of covariance analysis are valid. The summary of the single-variable covariance analysis results is presented in the table for cognitive functions in the experimental and control groups of students experiencing math and reading learning disorders.

**Table 2-** Summary of the single-variable covariance analysis results for cognitive functions in the experimental and control groups

effects	<u>SS</u>	<u>df</u>	<u>MS</u>	<u>F</u>	<u>sig</u>	<u>Eta</u>
Pretest (covariance)	47010.868	1	47010.868	1960.018	.000	.982
Skill training	1749.824	1	1749.824	72.955	.000	.670
disorder	29.044	1	29.044	1.211	.278	.033
error	863.457	36	23.985			

According to this table, F-test is 1960/018 for covariance variable or pretest which is significant in 0.01 level, and its elaborated variance value equals 0.982. F-test is 72.955 for the independent skill training variable (experimental and control groups) which is significant in 0.01 level and its elaborated variance value equals 0.670; i.e., 67% of dependent variance variable (cognitive functions' posttest score) is elaborated by the quadruple brain processing of skill training. The effect of intervention was not significant (F=1.211, P>0.05), therefore, there was no significant difference in the effectiveness of the quadruple brain processing skill training on the cognitive functions of the student's experiencing math and reading learning disorders. But, the subjects of

pretest condition had a significant effect on increasing posttest score, and quadruple brain processing skill training significantly increased their scores in the experimental groups in the cognitive functions' posttest (the experimental group mean was 281.729 and control groups mean was 263.321).

To examine the effect of quadruple brain processing skill training on the cognitive functions of both experimental groups of students suffering from math and reading learning disorder in pretest phase, posttest and follow-up stages of mixed measurement variance analysis were used (one factor with-in subjects and one between subjects). The triple stages of pretest, posttest and follow-up were considered as the with-in factor in the subjects and grouping subjects in the two groups were considered as the between-subject factor.

**Table 3-** hypothetical results of Sphericity in three stages

variable	Mauchly	$\chi^2$	df	sig	Huynh-Feldt
Cognitive function	.686	6.396	2	.041	.863

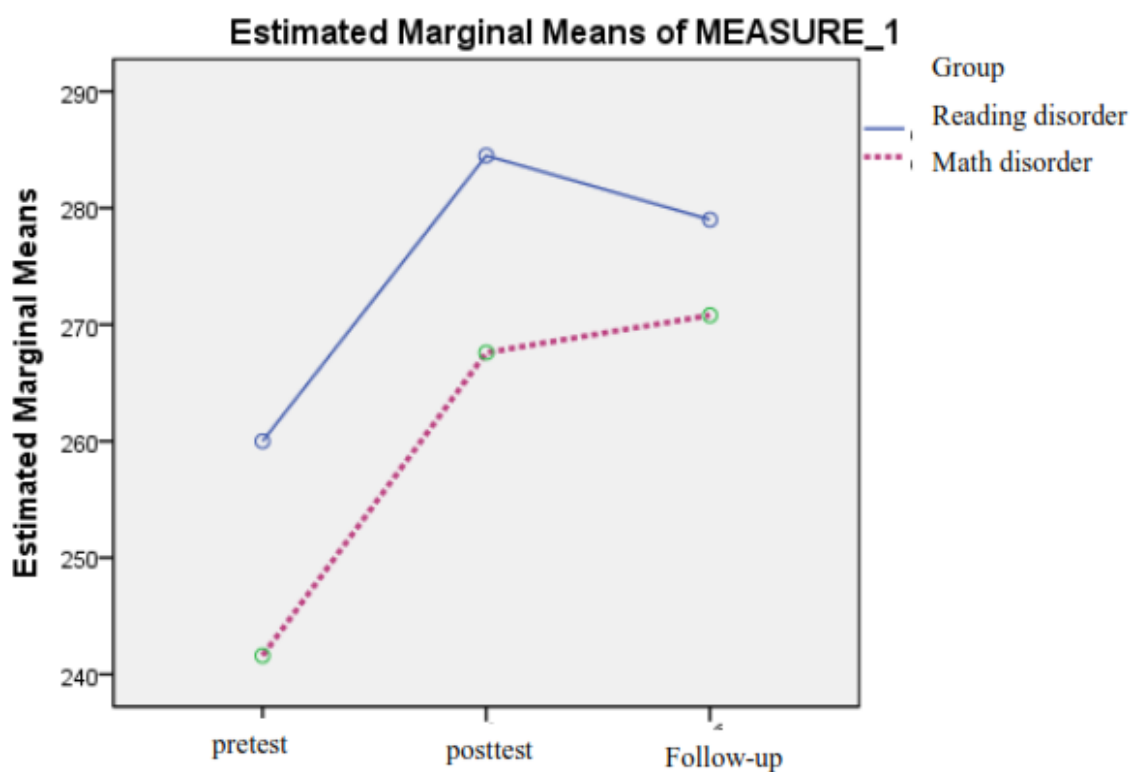
As the table illustrates, the Sphericity is not valid (the significance of this value is less than 0.05). Epsilon correction strategies are used in such cases. There are three estimations for it. The present study used Huynh-Feldt estimation due to the equality of sample size in the groups, thus, the index of Greenhouse Geisser Epsilon was used instead of the degree of freedom and the results of mixed measurement variance analysis results were calculated according to the non-establishment of Sphericity assumptions.

**Table 4-** the summary of mixed measurement variance analysis results on cognitive functions in two experimental groups

<b>intra-group factor</b>	<b>effects</b>	<b><u>SS</u></b>	<b><u>df</u></b>	<b><u>MS</u></b>	<b><u>F</u></b>	<b><u>sig</u></b>	<b><u>Eta</u></b>
	phases	8131.300	1.523	5340.484	125.663	.00	.875
	The interaction of group stage*	303.300	1.523	199.202	4.687	.026	.207
	error	1164.733	27.406	42.499			
<b>inter-group factor</b>	Group	3153.750	1	3153.750	.902	.355	.048
	error	62914.167	18	3495.231			

As the table shows, cognitive functions' change is significant in the three measuring stages of pretest, posttest and follow-up ( $F=125.633$ ,  $P<0.05$ ). the mutual effect of stages and group is significant in three measuring stages of pretest, posttest and follow-up ( $F=4.687$ ,  $P<0.05$ ). Indeed,

the process of cognitive functions' changing scores is different in posttest and follow-up in the two experimental groups. The effect size and degree were 0.875 and 0.207 in creating intra-group and inter-group differences, respectively. The effect of group membership was not significant (i.e., the effectiveness of quadruple brain processing skill training on the cognitive function had not significant difference in the students suffering from math and reading learning disorder). As a result, the evidence indicates that the quadruple brain processing skill training on the cognitive function in the students suffering from math and reading learning disorder has significant effect. The cognitive functions' graph of the students experiencing learning disorder in two groups of math and reading in three measuring stages was as follows.



**Chart-1.** Cognitive functions of the two experimental groups of students in the three measurement phases

As it is obvious from the graph, cognitive functions of the students in two groups in posttest and follow-up increased significantly comparing with pretest. The score of student's cognitive functions experiencing reading learning disorder in posttest in comparison with the students by reading learning disorder was higher, but in follow-up showed an increase, while the score of cognitive functions of students experiencing math learning disorder in the follow-up increased slightly; but there is no significant difference between two groups. Given the significance of the increase in the cognitive functions of the two experimental groups, pairwise comparison was carried out by the Benferoni test.



**Table 5-** pairwise comparison with the Benferoni test in the two experimental groups

group	phases	Mean difference	error	Significance
Reading disorder	Pretest-post test	24.50-	1.34	1.00
	Pretest- follow-up	-19.00	3.20	1.00
	Posttest- follow-up	5.50	2.59	.063
Math disorder	Pretest- posttest	-26.00	2.50	1.00
	Pretest-follow-up	-29.20	3.13	1.00
	Posttest-follow-up	-3.20	2.01	.146

As it can be seen in the table, there was a significant increase in the score of cognitive functions in two groups of students experiencing math impairment and reading impairment, in “posttest compared to pretest” and “follow-up compared to pretest” ( $P < 0.05$ ). But there was no significant difference in the cognitive functions’ scores in “follow-up compared to posttest”.

### Discussion and Conclusion:

The results of the study showed that there was no significant difference in the effectiveness of the quadruple brain processing skill training on the cognitive functions in the students experiencing math and reading learning disorder. But pretest subjects' condition has significant effect on increasing posttest scores, and quadruple brain processing skill training, also significantly increased their score, in the experimental groups, in the cognitive functions’ posttest. The examination of the effectiveness of the quadruple brain processing skill training on the cognitive functions in two experimental groups of the students suffering from math and reading learning disorder showed that, in pretest, posttest and follow-up phases, the quadruple brain processing skill training has significant effect on the cognitive function of students experiencing learning disorder in math and reading and it is found that, through Benferroni test, the scores of cognitive functions in two groups of the students by impairment in reading and math in “posttest compared to pretest” and “follow-up compared to pretest”, there was a significant increase, but the scores of cognitive functions in “follow-up compared to posttest” does not have any significant difference. Among the obtained results of the Siavashifar (19), Khanjani (20), Samadi (22), Birami (23), Taghizade (24), Fathi Aghtiyani (25), Soleimani (26), Child (18), Vicente (21), Amood (27), Landros Thomas (28), Leung (29) Cai’s (16) studies, there is an alignment and all the findings are supported. It should be acknowledged, in the finding’s elaboration, according to the Britani definition (30) that cognitive function is a general term that includes all the complex cognitive processes necessary in doing goal-oriented hard or new tasks and contains the ability to delay or specific response inhibition, as well as action sequence planning and maintaining mental representation task through working memory. According to Holmes perspective (31) conscious methods in the neuroscience can have positive effects on the brain growth and learning. Meanwhile, high potential and capacity



of mindfulness-based training practices on brain flexibility toward comprehensive learning and general health have been supported. Therefore, using cognitive functions is an appropriate method which is effective on the quadruple brain processing skill training in the students experiencing learning disorder in math and reading and must be taken into account.

#### **Suggested for further reading:**

- Workshops and training courses of quadruple brain processing skill training should be given serious attention by the educational system.
- Teaching some skills lead to an increase in the level of verbal comprehension in the students experiencing learning disorder. The following techniques can be referred to: taking notes of daily events, word games and increasing vocabulary range, doing some puzzles and crosswords, asking questions and etc.
- Teaching students how to “visualize” through using mind’s eye.
- Asking students to do puzzle games and make things in the form of “story telling”
- Expose students to “map reading”
- Introduce all kinds of spatial computer games to the students.

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