The Effectiveness of Cognitive Rehabilitation on Different Types of Attention in Third-Grade Students with Specific Learning Disabilities (Reading) Considering Moderating Role of Gender

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Abstract

The present study aimed to identify the effectiveness of cognitive rehabilitation on different types of attention in the third-grade students with specific learning disabilities (reading) considering moderating role of gender. As a quasi-experimental research, the study used pretest-posttest design with control group. Façade testing, a helpful tool to identify the reading difficulties and dyslexia in elementary school, was performed to determine the research sample among the third-grade students in Tabriz. The students who score above average survey response rate are identified as specific learning-disability learners (reading). Among these students, 60 (four groups of 15) are selected by simple random sampling method and randomly divided into two experimental groups (two groups of 15, one group female students and the other male students who received cognitive rehabilitation training program) and two control groups. Cognitive rehabilitation training is delivered through Smart Sound training software (8-level computer-based cognitive rehabilitation in reading disorder). Attention is also measured by focused/sustained attention and scattered attention test designed in Sina Institute. To analyze the data, multivariate analysis of covariance is used. The results indicate cognitive rehabilitation is effective in focused/sustained attention, scattered attention, and reaction time in specific learning-disability students and gender does not have a moderating effect. Accordingly, cognitive rehabilitation does not have meaningful effect in the increase of focused attention, scattered attention and reaction time in male and female students.

Keywords: Attention, cognitive rehabilitation, gender moderating role, specific learning disorder (Reading)

Introduction

Specific learning disabilities refer to deficits in which the affected child stands at lower stage in getting the expected skills in reading, writing, speaking, or mathematics comparing to the children in the same age and with admissible intelligence quotient (Baker, 2016). In DSM-5, learning disorder category has changed to specific learning-disability, in other words; formerly identified distinct and independent disorders such as reading, writing or math disorder, now are recognized as specific learning-disability. Hence, from now onwards, psychologists and psychiatrists will not claim the child suffers from learning disability, but will speak of their specific learning-disability (Enger, 2018).

According to last DSM-5, the time of learning-disability detection is when the progress in standardized tests for reading, mathematics, and writing is perceptibly lower to the required level in terms of age, intelligence and education (Van der Sluis et al., 2013). Children with learning-disability face with severe brain deficits in executive functions such as attention. When an attention is defined as the ability to actively process specific information and knowing the fact that information processing capacity is limited; thereupon, the participation of an individual in one or more task at the

same time becomes difficult. The major challenge of organizing large volume of data specializes for environments which require higher skill levels and a wide variety of information. Neurologists hold the attention is the outcome of interaction among different regions of brain and there is no certain region merely responsible for attention functions (Sterr, 2014). Regarding the fact that one of characteristics of attention is its limited resource, thus Anderson (1980) considered attention as a limited capacity resource. In fact, an individual is able to attend limited number of stimuli and when he attempts to direct attention to multiple stimuli, interference phenomenon takes place in a way that functions reduce to one of tasks. (Mortazavi, 2009)

In recent decades, a wide range of methods have been devised to rehabilitate attention for children with specific learning disorder among which cognitive rehabilitation is recognized as one of novel techniques by the therapists. Recently, there is a growing interest in using computers for the treatment of developmental disorder in cognitive problems which itself has led to the development of computer-based cognitive training programs (Gatian & Garolera, 2012). In fact, rehabilitation or cognitive training refers to cognitive science trainings in the form of computer games which attempt to improve or upgrade spatial functions, accuracy, attention, visual-cognitive perception (audio cleaning and other executive functions) all of which refer to the principle of neuroplasticity or brain plasticity (Thorell, 2019).

Owen et al. (2010) considered neuropsychological rehabilitation as a method which results from the integration of cognitive neuroscience with information technology. They delineated it can improve brain capabilities in cognitive functions such as perception, attention, consciousness, memory, and other functions. The results of a study conducted by Mazzocco and Hanich (2015) indicated neuro-psychological interventions are effective in improving educational performance and executive functions of children with learning disabilities. Moreover, the study of Kesles et al. (2018) demonstrated that computer-based cognitive rehabilitation program has significantly increased processing speed, verbal cognitive flexibility and cognitive vision and also had dramatic role in increased activity of the dorsolateral prefrontal cortex. In addition to all mentioned literature, many studies have firmly underlined that decreased motivation in doing homework and learning is one of the problems of children with various learning disorders. The studies have also suggested using computer and computer-based teaching programs (computer-games) can greatly help to solve such problems. Furthermore, various training programs have been developed to improve such

functions and their effectiveness has been proved in various studies. In addition, cognitive learning rehabilitation improves and enhances cognitive abilities by involving and applying a set of cognitive abilities in individuals. The use of software and computer games commensurate with abilities is one of the methods through which cognitive rehabilitation can be used. Such treatment takes advantage over other methods, especially medication, because it has no side effects. Children with Learning disabilities often have perceptive disorder, language impairment, phonological processing disorder and motor memory impairments. Attention deficit hyperactivity disorder has many comorbidities with learning disabilities. Some scholars have reported the degree of sympathy in this disorder 10 to 80% (Kamphaus & Frick, 2016). Because specific learning disabilities is connected with a range of other disorders which are more relevant to students' memory and attention, hence determining the effectiveness of methods which appear influential in the treatment of such disorder and their effects are of a great importance.

Gender is a variable that can play a moderating role in the students' learning disorders and cognitive rehabilitation. According to new studies, it is revealed that among students, female students appear better at reading and writing, and male students have lower reading impairments than female students. Australian researchers have displayed the gender difference in the standard experiments. Riley (2018) held it is common misconception that female and male students are common in cognitive abilities and learning disabilities in elementary schools. However, the present study proves the opposite. Moreover, gender difference is existed in anxiety disorder and attention deficit disorder which are connected to reading and writing problems and can disrupt the classroom. The studies by Van der Sluis, et al. (2013) have displayed female students use both brain hemispheres in reading and writing, but male students only use one side of their brain. Another point in response to this study is that female students perform more accurately than male students in tests. According to raised issue, the present study seeks to determine the effectiveness of cognitive rehabilitation on working memory capacity and attention of the third-grade students with specific learning disability considering moderating role of gender.

Children with cognitive disability have a poor performance in all of the visual –motor tests. Therefore, the detection and rehabilitation of such learning disabilities seem necessary. The purpose of the present study is to construct and normalize a learning disability test for pre-school students (Gholami et al., 2018).

Method

In terms of purpose, the present study followed applied research method and employed semi-experimental data collection with pretest-posttest and control group.

Table 1.
Pretest-Posttest Design with Control Group

Control and experimental group	Pre-test	Independent V.	Post-test
G_{E1}	T_1	X1	T_2
G_{E2}	T_1	X2	T_2
G_{C1}	T_1	----	T_2
G_{C2}	T_1	----	T_2

Participants

The statistical population of the study consisted of all the third-grade students with specific learning disorder (reading) in Tabriz. The study applies cluster sampling method to determine the research sample. Thus, among all regions of Tabriz, three regions (two, three and four) are randomly selected. In each geographical district, two schools and from each school three third-grade students are randomly selected.

Instruments

The Facade testing was performed to identify students with specific learning disorder. The students who scored above the average survey response rate were identified as students with specific learning disorder (reading). Having obtained parental consent, sixty selected students were divided into four groups (each group fifteen students) by simple random sampling method. From four groups two were experimental and two control groups. The experimental groups were placed within two groups: female students and male students and were given cognitive rehabilitation training. The other two control groups (one group female students and the other male students) did not undergo any therapeutic intervention. In sample selection, the selected students were preferred to be in similar educational achievement and cultural and economic characteristics.

Eligibility criteria for the study are: 1) age between 10-12 years old, 2) studying at third-grade of elementary school in Tabriz, 3) having specific learning disorder (reading), 4) normal or corrected vision, 5) normal hearing ability, 6) no mental retardation.

Exclusion criteria in research: 1) More than four sessions absence in cognitive rehabilitation training program, 2) failure to answer questions in pretest and posttest (for experimental and control groups), 3) unwillingness to participate in the research, 4) Having a physical disease.

Facade test was used to screen the students with specific learning disorder (reading).

Facade test is a tool to study the reading ability of normal female and male students in elementary school. It is formally used to identify suspected learning disabilities, dyslexic and reading problems which have been normativated (Karami et al., cited by Abolgasemi et al., 2013). This test consists of 10 subtests that are: word reading (classified by the three-differing frequency: high-frequency words, mid-frequency words and low-frequency words), words chain, rhyme, naming pictures, text comprehension, word comprehension, phoneme deletion, reading non-words or nonsense words, letter signs and category signage (Jane, 2012).

Focused and scattered attention test is used to study attention. This test was designed by Sina Institute in collaboration with Dr. Monavar Yazdi to measure focused and scattered attention in different age groups. It is performed in two stages: first, the focused attention test is performed. In the way that two alphabetic letters (for example M & S) are displayed on the monitor screen. Then the experiment starts. When letters are displayed, the subject must start marking the answers. In case of displaying other letters, he has to stop marking. The time interval between the two stimuli is half a second which is changeable. The type of letters is also variable. Then scattered attention test is performed. In this stage, both of above letters are displayed on both sides of the monitor screen. The subject has to use right hand to answer the right stimulus and left hand to answer the left stimulus. In case of change, he has to stop answering. In this time, giving answer is an error. The pretest-posttest correlation coefficient is to measure to check the reliability in focused and scattered attention software (the interval will be one month). In studying the validity between inconsistent answers in Stroop test and focused attention in the focused and scattered attention test among 300 subjects with and without accident, the study obtained the correlational coefficient of 0.390 in a very meaningful and significant way (Zare et al., 2012).

Procedure

In the present study, cognitive rehabilitation training was provided to the experimental group by the Smart Sound training software program. Smart Sound program is an appealing educational program designed like computer games. This program has eight different level games. In addition to teaching and giving alphabetic letter practices, Smart Sound improves attention and motor memory skills, auditory skills, letter spelling and pronunciation, phonetic distinction, reading in third-grade of elementary school, compliance orders, brain processing speed and even impulse control, and finally all skills that are essential for successful life and education. This program is one of the best and most effective mental health education programs introduced by Brain Train Company. It has been localized by a group of computer specialists and psychologists in Parand Institute of Cognitive Sciences, Tehran. Smart Sound program has unique effects on children's cognitive abilities, especially in pre-school and elementary school years. Therefore, in the current study Smart Sound software program was presented to each experimental group in nine sessions for thirty to forty-five minutes. In the first session, the procedure and its various steps were explained. Then eight training sessions were presented to each subject

Table 2.

Instructional Sessions for Cognitive Rehabilitation

Session	Game	Cognitive Rehabilitation	Time (min)
1	Competition point	Response inhibition, processing speed, general attention	30
2	Cats game	Response inhibition, visual processing speed, visual perception, general attention	40
3	Mouse hunt	Response inhibition, visual processing speed, focused/sustained attention	30
4	Practicing goal	Response inhibition, selective attention, focused/sustained attention, visual perception	30
5	Red light, green light	Response inhibition, visual processing speed, visual perception, general attention	30
6	Quick selection	Response inhibition, general attention, visual perception	30
7	Darts	Response inhibition, general attention, visual perception	30
8	On the road	Response inhibition, general attention, visual perception	

In the present study, the data obtained from the questionnaire in pretest-posttest was analyzed employing descriptive statistical methods like mean, standard deviation, and frequency distribution. In addition, the hypotheses were analyzed taking inferential statistical methods of multivariate factor analysis of covariance. To analyze data, SPSS 22 software was used.

Findings

The following tables display descriptive data for research variables in the two experimental and control groups and two pretest-posttest stages:

Table 3.

Descriptive Data for Research Variables

Variables	Test	Control group		Experimental group	
		Mean	S.D	Mean	S.D
Total Attention Score	Pre-test	108.60	8.57	106.46	6.90
	Post-test	112.26	5.28	112.26	8.10
Scattered Attention	Pre-test	34.46	2.32	20.33	2.67
	Post-test	34.60	3.01	35.66	2.60
Focused/Sustained Attention	Pre-test	51.13	4.51	49.86	3.75

Variables	Test	Control group		Experimental group	
		Mean	S.D	Mean	S.D
	Post-test	52.60	3.83	53.86	3.50
Reaction Time	Pre-test	14.80	1.26	16.26	1.86
	Post-test	14.93	1.43	14.80	1.37

Hypothesis 1: Cognitive rehabilitation affects attention in students with specific learning disabilities (reading).

Multivariate analysis of covariance (MANCOVA) was used to study the positive effect of cognitive rehabilitation on the attention of students with specific learning disabilities (reading). Attention has three subscales: focused/sustained attention, scattered attention and reaction time. This section examines the presumptions for multivariate analysis of covariance (MANCOVA). Initially, slope homogeneity, a basic assumption of covariance analysis (ANCOVA), is examined. The results are reported in the following table:

Table 4.
Studying Homogeneity of Regression Slops

D.V.		Total Squares	df	Mean of Squares	f	Sig.
Group in pre-test	Scattered attention	32.735	2	16.368	3.185	0.60
	Focused/sustained Attention	57.562	2	28.781	2.413	0.112
	Reaction Time	14.040	2	7.020	3.360	0.052

Due to the fact that significance level of all the three variables of scattered attention, focused attention and reaction time is higher than 0.05, it can be claimed that the assumption of homogeneity of regression slopes is established. And there is a linear relationship between dependent variables and covariates within groups. Leven's test was used to investigate the equality of variance assumption in the studied groups which is another presumption of ANCOVA. The results are displayed in the following table:

Table 5.
Leven's Test to Examine the Assumption of Equality

D.V.	F	Df1	Df2	Sig.
Scattered Attention	0.002	1	58	0.968
Focused Attention	3.722	1	58	0.229
Reaction Time	1.510	1	58	0.064

The results of above table indicate the significance level of all the three variables: focused attention, scattered attention and reaction time is higher than 0.05 and therefore, the equality of variance assumption is established in the studied groups. The equality test of the observed covariance matrices is another presumption of multivariate covariance test among different groups. This test was carried out using Box's M test displayed in following table.

Table 6.
Box's M Test for the Equality of Observed Covariance Matrices of the Dependent Variables among the Groups

Box' M	F	Df1	Df2	Sig
9.924	0.724	6	53.803	0.630

Based on above table, when the value of F (0.724) is not significant at the given error level (0.630); therefore, the null hypothesis is not rejected. This means that the observed covariance matrices are equal between different groups. Among the four statistics tests (Pillai's Trace, Wilks' Lambda, Hoteling's Trace, Roy's Largest Root), the researcher has chosen Wilks' Lambda statistics to test the hypothesis.

Table 7.
Multivariate Analysis of the Effect of Cognitive Rehabilitation on Attention

Multivariate Test	Statistic	F	Hypothesis Df	Error Df	Sig.
Wilks' Lambda	0.621	4.674	3	53	0.011

Based on above table, the Wilks' Lambda statistics test with F=4.67, P≦0.05 indicates that the hypothesis of average community similarity based on dependent variables for the control and experimental groups can be rejected.

Table 8.
Results of MANCOVA Effect of Cognitive Rehabilitation on Attention

Model	D.V.	Total Squares	df	Mean of Squares	F	sig
Group	Scattered Attention	22.507	1	22.507	4.286	0.049
	Focused/sustained Attention	12.092	1	12.092	6.347	0.019
	Reaction time	17.163	1	17.163	8.542	0.007
Error	Scattered Attention	131.275	55	5.251		
	Focused/sustained Attention	375.605	55	15.024		
	Reaction time	50.229	55	2.009		
Total	Scattered Attention	30772	60			
	Focused/sustained Attention	83201	60			
	Reaction time	7326	60			

The test results of intergroup effects in the posttest with reducing effect of pretest in above table display there is a meaningful difference between the two means in the experimental and control groups in the subscales of scattered attention, focused/sustained attention and reaction time. The study of mean scores in the experimental and control group in table 1-4 display that the cognitive rehabilitation results in an increase in scattered attention, proximity problem, and a decrease in reaction time.

Hypothesis 2: Gender factor is able to moderate the effect of cognitive rehabilitation on attention in students with specific learning disabilities (reading).

To study the second hypothesis, multivariate analysis of covariance (MANCOVA) has been used to test the role of gender moderator in positive effect of cognitive rehabilitation on the attention of students with specific learning disabilities. Attention has three subscales: scattered attention, focused/sustained attention and reaction time.

This section studies the presumptions of multivariate analysis of covariance (MANCOVA). First, the study examines the hypothesis of slopes homogeneity which is one of the basic assumptions of covariance analysis. The results are reported in the following table:

Table 9.
Examining Homogeneity of Regression Slops

	D.V.	Total Squares	df	Mean of Squares	f	Sig.
Group in Pretest by Gender Moderation	Scattered Attention	63.08	4	15.770	3.319	0.26
	Focused/sustained Attention	174.1	4	43.504	3.204	0.051
	Reaction time	38.225	4	9.556	4.852	0.30

Since the significance level of all three variables of focused/sustained attention, scattered attention and reaction time is higher than 0.05, thus, it can be maintained that the assumption of homogeneity of slope regression to carry out analysis of covariance (ANCOVA) is established. And also, there is a linear relationship between dependent variables and auxiliary variables within the groups.

The equality test of the observed covariance matrices of dependent variables is another presumption of multivariate covariance test among different groups. This test carried out using Box's M test. The results are displayed in following table.

Table 10.
Box's M Test, Equality of the Observed Covariance Matrices of Dependent Variables among the Groups

Box's M	F	Df1	Df2	Sig
18.608	0.809	18	22.82	0.692

According to the results of above table, since the value of F (0.809) is not meaningful in the given error level (0.692), accordingly the null hypothesis is not rejected. It means that the observed covariance matrices are equal among different groups.

Among the four statistics tests (Pillai's Trace, Wilks' Lambda, Hoteling's Trace, Roy's Largest Root), the Researcher has chosen Wilks' Lambda statistics to test the hypothesis.

Table 11.
Multivariate Analysis of Moderating Role of Gender in Affecting Cognitive Rehabilitation on Attention

Multivariate Test	Statistic	F	Hypothesis Df	Error Df	Sig.
Wilks' Lambda	0.804	1.707	3	53	0.196

Based on the above table, the Wilks' Lambda statistics with F=1.07, P≦0.169 displays that the hypothesis of average community similarity based on dependent variables for control and experimental groups cannot be rejected.

Therefore, it can be held that gender does not have a moderating role in the effect of cognitive rehabilitation on attention.

Discussion

The research findings indicated that cognitive rehabilitation improves the function of scattered/focused attention of students with specific learning disorder (reading) and gender does not have a moderating effect of cognitive rehabilitation on attention of students with SLD (reading). In the same way, Ponce, Lopez, Mayer (2012) studying the effectiveness of computer programs in teaching comprehension strategies for fourth-grade elementary school students in Chili proved that learning in a computer-based environment is greatly effective. In addition, Kast, Baschera, Gross, Jancke, and Meyer (2011) studied the effect of computer-based spelling skills training on two groups of dyslexia and normal students and concluded that dyslexia students developed spelling skills as much as non-dyslexia students. Also, attention level of dyslexic children had increased through such instructional program.

The findings of the current study can be explained based on the hypothesis of neuroplasticity due to neuropsychological exercises. For example, Mant et al. (2012, cited by Nazifi et al., 2018) observed the increase in volume of gray and white matter in different areas of the brain; while taxi drivers displayed structural differences in their hippocampi compared to the normal

people which probably due to the extensive use of current area in processes such as orientation and visualization. Therefore, it is assumed that the same mechanism that underlies the formation processes depended on experience, can produce automatic or guided improvements (through rehabilitation) in such disorders. Moreover, it can be acknowledged that poor attention span is a characteristic of children with learning disabilities. And it seems that the processes of memory system and mental databases for them are affected. In the critical years of elementary school, focus on attention is a prerequisite for every training including reading. In general, it can be explained through brain plasticity hypotheses that the possible effects of cognitive rehabilitation software are due to cognitive exercises and their repetition. Thereupon, it is assumed that the same mechanism which underlies formation processes produces automatic and guided improvements (through rehabilitation) in such disorders. During the critical years of elementary school, concentration in attention is prerequisite of learning everything including reading.

Conclusion

In general, based on the hypothesis of brain shaping, it can be explained that the probable effects of cognitive rehabilitation software are formed through cognitive exercises and repetition of these exercises. Accordingly, it is assumed that the same mechanism which is the basis of shaping processes depends on experience and makes automatic or guided improvements (through rehabilitation) in such disorders. Hence, well-designed cognitive training programs can produce lasting improvements in the executive functions of students

with learning disability. Frequent and guided cognitive trainings (such as cognitive rehabilitation) can produce structural and functional changes in the neurons responsible for functions in the brain of children with learning disability. Based on neuroplasticity and self-healing brain hypothesis, such changes can be sustained. The present study had some limitations which can be referred to the absence of bilingual sample students. For this reason, generalizations should be made with caution. It is recommended that the future studies can apply cognitive rehabilitation program for the other neurodevelopmental disorders such as memory and hyperactivity. Furthermore, beside neurological tests, actual and daily performance of these individuals (SLD) should also be checked in school environment and in terms of school homework.

Acknowledgments

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