



Effectiveness of Attention Training based on Fletcher's Program, Delacato's Neuropsychological Treatment, and Computerized Cognitive Rehabilitation on Executive Functions in Children with Special Learning Disability

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Abstract

Background: We aimed to compare and determine the effectiveness of three methods of attention training based on Fletcher's program, Delacato's neuropsychological treatment, and computerized cognitive rehabilitation, on executive functions of children with special learning disability (SLD).

Methods: This was a four-group pretest-posttest design with a control group (three experimental groups and one control group) quasi-experimental study. The population included all students aged 7 to 12 years with learning disorders referred to the learning disorders treatment centers in Tehran during 2019. First, 40 students were selected from these centers by convenience sampling. This number was then randomly divided into four groups of attention training based on Fletcher's program, Delacato's neuropsychological treatment, computerized cognitive rehabilitation, and one group as a control group (N=10). Three methods of attention training based on Fletcher's program (12 sessions of 45 minutes), Delacato's neuropsychological method (12 sessions of 50 minutes), computerized cognitive rehabilitation (10 sessions of 30 minutes individually), were separately trained to the three experimental groups. Gerard and colleagues' Behavioral Rating Inventory of Executive Functions (parent form) was used to collect data.

Results: The results of the study revealed that the three methods were effective on executive functions in children with a SLD ($P < 0.05$). Based on the results of the post hoc test, the scores of both attention training groups based on Fletcher's program and computerized cognitive rehabilitation method were significantly different from the control group ($P < 0.0001$). This indicates that both interventions had an effect on increasing the executive function of children with SLD, but there was no significant difference between the three experimental groups ($P > 0.05$).

Conclusion: Given that computers are available in almost all schools, such programs can be considered as part of the curriculum for students with learning disabilities. Accordingly, through Fletcher's attention-based training method and computerized cognitive rehabilitation improved the performance of this group and prevented the creation of a defective process of failure in these students by improving their executive functions.

Keywords: Executive functions; Special learning disability; Attention-training; Fletcher's program; Delacato's neuropsychological treatment; Computerized cognitive rehabilitation

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Introduction

One of the issues that has long been considered by researchers is learning disability. In the Diagnostic and Statistical Manual of Mental Disorders (DSM-5), learning disabilities have been renamed special learning disability (SLD), and reading disorder, writing disorder, and math disorder, each of which was once considered independent and distinct disorders, are now included as a determinant

of an SLD.¹ Learning disability is defined as a problem with learning to read, write, count, and math observed during a formal school year. Learning disabilities are the most important cause of poor academic performance. Every year, many students have difficulty learning the curriculum because of this disorder.² In Iran, an overall prevalence of 4.58% has been reported for children with learning disabilities in primary school students. The

number of students with learning disability has gradually increases from 6 to 11, and most of them are boys in the age range of 10-15 years.³ The results of studies indicate that the prevalence of these disorders varies from 2% to 30%.⁴

Among the factors that can affect students with special learning disabilities are executive functions. In general, executive functions involve a set of cognitive skills responsible for designing, initiating, and sequencing complex, goal-oriented behaviors controlled by the prefrontal lobe area of the frontal lobe in the brain.^{5,6} Executive functions help us perform goal-oriented behaviors and prevent people from behaving passively in the face of environmental stimuli. In other words, it causes people to pursue their goals and this is the reason why these functions are important for success in the daily lives of humans, especially children.^{7,8} Children with reading disorder also have difficulty with functions such as working memory, attention, stable choice, flexibility, and phonological production.⁹ According to research, children with learning disabilities have difficulty in their executive functions.¹⁰

In the meantime, group and individual therapies have been designed and implemented. One of the critical training method to improve executive function in children with SLD is the attention training based on Fletcher's program. Lack of attention is one of the major problems for students that disrupts the education process and reduces their academic performance. Therefore, the need to use attention training based on Fletcher's program is felt. Attention is defined as the possession of the mind in a purposeful and focused way on a particular subject, thought, or object for several things at a time.¹¹ In a cognitive activity, first, our attention is drawn to the stimulus, and then we perceive it. Therefore, attention is very important in cognitive, behavioral, and mental performance because even small deficiencies affect learning performance.¹¹ Components of attention include emotion and attention regulation, selective attention, sustained attention, alternating attention, divided attention, inhibitory, and behavior control.¹² However, it is difficult to identify and measure the components of attention because attention is usually assessed concerning some other activity and because multiple parts of the brain affect the processing of attention.¹¹ Fletcher et al¹³, McCloskey et al¹⁴ and Espy and colleagues¹⁵ stated that children's ability in executive functions and attention in preschool could well predict their reading and math skills in the coming years as well. Learning disabilities in various fields hinder academic achievement.¹³⁻¹⁵

Delacato's neuropsychological treatment is a useful method of treating children with learning disabilities, which is referred to as the learning process.¹⁶ Delacato's method is the prevention and elimination of learning disabilities by neuropsychological or neural

systematization, which is also known as sensory-motor.¹⁷ This method is based on a series of physical exercises and assumes that the selected sensory-motor exercises lead to hemispheric improvement, and this issue improves learning disability in student.¹⁸

Another essential training for improving executive function in children with SLD is computerized cognitive rehabilitation. In cognitive rehabilitation, specific cognitive exercises are provided for each patient based on neuropsychological, laboratory, and behavioral counseling tests. These cognitive exercises mainly emphasize the attention functions, resistance to distraction, and conceptual flexibility.¹⁹ Cognitive rehabilitation therapy is based on brain neural plasticity principles, which include targeted exercises to improve various areas of cognition, such as attention, memory, language, and executive functions.²⁰ In this treatment, first, the basic skills are improved, then it becomes more difficult to fit the exercises, and a report on the progress of the exercises is provided to the therapist. Cognitive rehabilitation is an effective way to improve cognitive functions.²¹ In this regard, one study showed that computerized cognitive rehabilitation programs affect the inhibition of students' logical response and reasoning and improve their cognitive aspects.²²

Considering the long-term consequences of learning disabilities and the widespread prevalence of this disorder, as well as the problems it creates for the individual, family, and community, the inadequacy of common treatment methods, the importance of paying attention to this group of disorders and the need to use new treatment strategies in this disorder are obvious. Therefore, we aimed to compare the effectiveness of three methods of attention training based on Fletcher's program, Delacato's neuropsychological treatment, and computerized cognitive rehabilitation on executive functions of children with SLD.

Materials and Methods

This research was a quasi-experimental study with a pre- and post-test and control group design (three experimental groups and one control group). The study population consisted of all students aged 7-12 years with SLDs referred to the Learning Disabilities Centers in Tehran during 2019. First, 40 people were selected from the clients of these centers by convenience sampling method. Then, this number was randomly divided into four groups of attention training based on Fletcher's program, Delacato's neuropsychological treatment, computerized cognitive rehabilitation, and one group as a control group (N=10). We included first to sixth-grade elementary students who gave consent to participate in the study, and had been referred to learning disabilities centers based on the teacher's diagnosis, psychiatrist's diagnosis of learning disability, with moderate to high

intelligence (no mental retardation), who no mental disorders or acute physical illness, hyperactivity disorder, and lack of attention, and were not under any psychological and pharmacological treatments in recent months. Exclusion criteria were unwillingness to participate in the study, history of participating in similar individual and group treatment programs, being absent in the meetings for more than two times, IQ below 85, students with learning disabilities due to visual, auditory, motor impairments, mental retardation or emotional distress, or environmental, cultural or economic deprivation. Three methods of attention training based on Fletcher's program (12 45-minute sessions), Delacato's neuropsychological method (12 50-minute sessions), and computerized cognitive rehabilitation (10 30-minute individual sessions) were separately performed for the three experimental groups. Gerard and co-workers' (2000) Behavioral Rating Inventory of Executive Functions (parent form) was used for data collection.

Statistical Analysis

To analyze the data, multivariate analysis of covariance (MANCOVA), analysis of covariance (ANCOVA), and multivariate post-hoc tests were used. SPSS software version 24 was used for analysis. Normal score distribution was assessed by Kolmogorov-Smirnov test, homogeneity was assessed by Levene's test and covariance's matrix homogeneity presumption by Box's M test. $P < 0.05$ was considered as statistically significant.

Procedure

After obtaining the necessary permits, the researcher referred to learning disability centers in Tehran for sampling. At the discretion of the children's school teacher, they are referred to these centers, and in this center, with the expert diagnosis and revised Wechsler IQ test, the children are finally diagnosed with learning disabilities and are admitted to the center. First, after the psychiatrist confirmed the learning disability, then the executive functions questionnaire (parent form) was filled out by one of the parents (pre-test). In the initial appraisal, students who had the inclusion criteria were enrolled. Students were homogeneously divided into four groups of 10 based on sex, age, IQ, severity, and range of disorder, and parents' education level. Then, the mentioned three methods were separately performed for the three experimental groups. During this period, the control group did not receive any intervention. After 7-10 days of treatment, the students' parents were re-evaluated (post-test) by the executive function test (parent form).

Behavior Rating Inventory of Executive Function

In 2000, this questionnaire was designed by Gioia and colleagues to assess children and adolescents aged 5-18 years. This tool has two forms for parents and teachers,

including 86 questions that are rated "never", "sometimes", and "always" by parents from 1 to 3, respectively, in which the child's behaviors are examined at school or home.²³ It takes 10 to 15 minutes to complete this form. This questionnaire measures eight major executive functions: inhibition, self-control, initiation, planning, controlled attention, organization, monitoring, and working memory. The validity coefficient of this questionnaire for clinical samples in the parents' form is 0.82-0.98, and when it is used to assess the normal population, it is between 0.80-0.97.²³

Attention Training Based on Fletcher's Program

This training aims to increase attention in 12 sessions, lasting for 45 minutes. This training was performed based on Fletcher's program and in groups. This method aims to improve the level of auditory attention, visual attention, visual recognition, recognizing the shape from the background, and maintaining attention.²⁴

Delacato's Neuropsychological Method

This treatment's purpose is to improve motor and physical methods and was done in groups in 12 sessions of 50 minutes based on the Delacato's treatment model. This method is based on a series of physical-motor exercises. In this method, it is assumed that the selected sensory-motor exercises are used to lead to the improvement of the hemispheres, and this issue improves the learning disability in the affected students.¹⁶

CogniPlus Cognitive Rehabilitation Software

This software was designed and produced in 2004 by Sturm et al to teach basic cognitive functions (including continuous attention, direct attention, selective attention, working memory, vigilance, and visual-motor coordination). In this method, by performing cognitive exercises, the person develops basic cognition skills that are based on many daily activities, especially learning. Computer game activities such as attention, auditory and visual memory are presented. By focusing on the exercises provided in this method, one's cognitive skills are improved as a result of successive successful trials.²⁵

Results

The means and standard deviation (SD) of the dependent variables of the studied groups' executive function in the pre-test are given in Tables 1 and 2. As shown, in the pre-test stage, the means of the dependent variable of executive function were not significantly different in the three groups and were almost equal (Table 1).

Table 2 shows the mean and SD of the dependent variable of the three groups' executive function in the post-test. As shown, there was a difference between the means of the dependent variable of executive function in the three groups; the significance of this difference is

Table 1. Mean and Standard Deviation (SD) of Executive Function in Pre-test Stages

Variable	Group							
	Attention Training Based on Fletcher's Program		Delacato's Neuropsychological Treatment		Computerized Cognitive Rehabilitation		Control	
	SD	Mean	SD	Mean	SD	Mean	SD	Mean
Inhibit	4.49	22.30	2.14	23.7	3.99	17.20	3.87	18
Shift	2.19	18.70	3.28	18.70	2.19	15.70	2.16	17.90
Emotional control	1.80	16.60	2.45	17.70	2.57	16.50	1.74	17.40
Initiate	1.95	13.30	2.08	13.20	1.35	12.60	2.18	13/20
Working memory	2.80	17.90	2.37	19.40	2.22	17.80	2.37	18.60
Flexibility	4.29	21.60	4.14	23	3.52	21.30	5.27	22.30
Organization of materials	1.95	13.60	1.88	14.20	1.95	11.60	1.44	14.10
Executive function	26.10	142.70	10.04	144.60	14.01	127.80	12.10	136.30

Table 2. Mean and Standard Deviation (SD) of Executive Function in Post-test Stages

Variable	Group							
	Attention Training Based on Fletcher's Program		Delacato's Neuropsychological Treatment		Computerized Cognitive Rehabilitation		Control	
	SD	Mean	SD	Mean	SD	Mean	SD	Mean
Inhibit	3	22.40	2.28	22.70	3.58	15.40	4.91	19.20
Shift	2.93	15.40	2.97	18.40	2.37	15.50	2.07	17.90
Emotional control	3.03	15.60	1.85	17.50	2.66	16.1	1.88	17.80
Initiate	2.22	12.20	2.20	12.50	2.04	12	1.73	13
Working memory	2.83	16.70	2.38	17.90	2.10	16.30	2.21	18.90
Flexibility	4.08	19.50	3.56	21.90	3.92	21	6.55	23.70
Organization of materials	1.85	11.50	2.03	13.20	2	11.30	1.04	14.90
Executive function	14.94	128.10	9.83	138.40	11.39	120.81	11.65	139.10

examined as follows.

To know whether these changes in the experimental groups in the pre- and post-test stages were statistically significant or not, MANOVA and ANOVA were used. For performing these tests assumptions such as normality of the distribution of scores, the homogeneity of variances, and the regression slope's homogeneity, were first examined. The results of the Kolmogorov-Smirnov test showed that there was no significant difference between the scores of the two groups, and the data had a normal distribution ($P>0.05$). Besides, in examining the homogeneity of variances, the results of Levene's test showed that there was no significant difference between the variances of the two groups ($P>0.05$). Finally, the assumption of the regression line slope's homogeneity was investigated and confirmed ($P>0.05$). As shown in Table 3, we found a significant difference between the variables in the pre-test and post-test, and at least one mean was different from the other means.

As shown Table 4, the executive function scores in the post-test were significantly different from the executive function scores in the pre-test, which indicates that the interventions were particularly effective on executive

function ($P<0.05$).

Based on the post hoc test results, which compares two variables, a comparison was made between the executive function in the experimental groups and the control group. With respect to executive function, the scores of both attention training groups based on Fletcher's program and computerized cognitive rehabilitation method were significantly different from the control group ($P<0.0001$). This indicates that both interventions had an effect on increasing the executive function of children with SLD, but there was no significant difference between the three experimental groups ($P>0.05$). Also, after the intervention, the students' performance scores in the Delacato's neuropsychological treatment group were not significantly different from any of the studied groups ($P>0.05$). Therefore, due to the small sample size, to show the difference between the interventions, the groups' average should be taken into account (Table 5).

Discussion

We aimed to compare and determine the effectiveness of three methods of attention training based on Fletcher's program, Delacato's neuropsychological method and

Table 3. Results of covariance analysis

Test	Value	Df _{Hypothesis}	Df _{error}	F	P	Eta
Pillai's trace	0.903	4	50	10.296	0.000	0.452
Wilks' lambda	0.163	4	48	17.720	0.000	0.596
Hotelling's trace	4.720	4	46	27.180	0.000	0.703
Roy's largest root	4.640	2	25	58.002	0.000	0.823

Df: degrees of freedom.

Table 4. Inter-subject effects test

Variables	Source	SS	Df	MS	F	P	Eta
Executive function (post-test)	Group	1415.23	3	471.74	9.85	0.000	0.742
	Error	1674.90	35	47.85			
	Total	312541.00	39				

SS: sum of squares, Df: degrees of freedom, MS: mean square.

computerized cognitive rehabilitation on executive functions of children with SLDs. The results revealed that the interventions affected the executive function of these children. Our results are consistent with the findings of previous studies.²⁶⁻²⁹ Cognitive rehabilitation increased social cognition, inhibitory control, and cognitive avoidance of students with learning disabilities.²⁶ Moreover, teaching executive functions could be used as an intervention method in inhibiting and improving the attention function of students with math learning disabilities.²⁷ Motor skills training was effective on cognitive abilities and executive functions of children with SLD.²⁸ The use of computerized cognitive education was a promising intervention for children with functional memory deficits, especially in the field of visual working memory.²⁹

Children with learning disabilities have poor performance in executive functions. Executive functions predict success in reading and math, memorizing and following instructions, completing assignments, and inhibiting inappropriate behavior, and play an important role in knowledge acquisition. Executive functions include cognitive processes that are responsible for goals, performance maintenance strategies, and cognitive planning in the mind until other irrelevant behaviors or stimuli are performed and inhibited. In general, executive

functions can be described as an indicator of “how” and “when” to perform normal behavioral functions.^{30,31} Executive functions in the prefrontal cortex involve cognitive processes and grow prominently in preschool age.³²

In other words, with the components of attention, including sustained, selective, and divided attention, children are taught using games to increase and improve attention, and consequently improve and strengthen their performance. Therefore, attention training can improve learning disability problems. Strengthening attention as a prerequisite for the psychological nerve leads to the improvement of learning disabilities in students. Also, in another explanation, it can be said that attention is one of the neuropsychological skills that is a prerequisite for various courses, including elementary courses. Therefore, teachers should pay attention to the factor of attention in teaching. In their research, Mazzocco and Hanich showed that neuropsychological interventions such as attention training are effective in improving the academic performance of children with SLD.³³ Another explanation in this section shows Delacato’s therapy’s effectiveness, which involves reorganizing the central nerves. This method is based on movement therapy and neuromuscular retraining programs such as rolling, crawling in different shapes, moving on all fours with a cross pattern, walking with a cross pattern, hearing training, vision training, and effort orientation. It mobilizes and employs previously acquired patterns of movement from the lower parts of the brain.^{34,35} In other words, in Delacato’s view, readiness to read and write is related to the complete nervous system, and children whose nervous system is not adequate, have speech and writing problems. This theory’s assumes that movement can be used to improve and develop cognitive and perceptual skills and treat children with SLD.³⁶ By performing Delacato’s sensory-motor movements, the brain is used again from a motor and sensory point of view, and learning disabilities are reduced. In other words, although we cannot resurrect dead brain cells, we can activate many inactive living cells.¹⁶ Therefore, in this study, according to this principle in Delacato’s theory and using the treatment steps mentioned by him, an attempt was made to give children opportunities to manipulate

Table 5. Multivariate Analysis (Post Hoc Test)

Variable	Group (I)	Group (J)	Mean Difference	SD	P
Executive Function (Post-test)	Attention training based on Fletcher’s program	Delacato’s neuropsychological method	-8.679	3.20	0.051
	Attention training based on Fletcher’s program	Computerized cognitive rehabilitation	-5.410	3.42	0.738
	Attention training based on Fletcher’s program	Control	16.459	3.16	0.000
	Delacato’s neuropsychological method	Computerized cognitive rehabilitation	3.292	3.50	0.681
	Delacato’s neuropsychological method	Control	7.780	3.20	0.122
	Computerized cognitive rehabilitation	Control	11.049	3.20	0.000

*SD: Standard Deviation, P: P-Value

and search in their surroundings, use their superior senses and limbs more than the non-superior limbs so that the relevant hemisphere, which is opposite to the superior limbs, is sufficiently superior to the other hemisphere. Delacato's therapy was found effective in people with reading disorders¹⁷ and increased reading scores, speed, and comprehension,³⁷ which is in line with the findings of the present study.

In explaining the cognitive processes involved in learning disabilities, the cognitive rehabilitation program, which focuses primarily on improving cognitive abilities, is a unique treatment type. Cognitive computerized training programs provide tools that can help improve the basic mental processes essential in high-level learning.³⁸ Cognitive rehabilitation of art and science is the reconstruction of mental processes and the teaching of compensable strategies. A fundamental principle in computerized cognitive rehabilitation is improving the core of cognitive abilities, including inhibitory control and the need for self-control to achieve academic and cognitive success.³⁹ Cognitive rehabilitation is a way to restore lost cognitive capacity through exercises and the provision of purposeful stimuli. In one study, computer cognitive retraining could help improve the performance of children with learning disabilities.⁴⁰ One of the limitations of this study was convenience sampling, and a small sample size, which makes the generalizability of the findings difficult. Another limitation of this study was the lack of a follow-up stage, which suggests that evaluation in the follow-up stage should also be considered in future research.

Conclusion

Given that computers are available in almost all schools, such programs can be considered as part of the curriculum for students with SLD. Accordingly, through Fletcher's attention-based training method and computerized cognitive rehabilitation improved the performance of this group and prevented the creation of a defective process of failure in these students by improving their executive functions.

Conflict of Interest

The authors declare that they have no conflict of interests.

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Authors' Contribution

SOE designed the study and supervised the project. MAK gathered the data and drafting the manuscript. RH performed statistical analysis and drafting the manuscript. All authors have seen and approved the final Manuscript.

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Ethical Statement

In the present study, to comply with ethical considerations, the study's objectives were explained and all participants were assured that their information would remain confidential. If the patient did not want to participate in the study, he/she would not be enrolled. In the end, written informed consent was obtained from the participants. This study was approved by the Ethics Committee of the Islamic Azad University, Sari branch (code IR.IAU.SARI.REC.1398.080).

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