Document Type: Original Article
https://dorl.net/dor/20.1001.1.26455455.2021.4.13.4.4

Iranian Journal of Learning and Memory 2021, 4(13), 38-46

The Effect of Computerized Cognitive Rehabilitation (CCR) on Verbal Skills of the Students with Mathematical Learning Disorder

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Abstract

This article aimed to study the effect of computerized cognitive rehabilitation (CCR) on verbal skills of students with specific mathematical learning disorder (SPLD). Forty people were selected using simple random sampling method from among the primary fourth grade male students with SPLD in Karaj; they were divided into experimental (n=20) and control (n=20) groups after matching using random substitution. The study was a quasi-experimental study with a pre-test-post-test design with a control group and a two-month follow-up. The subjects in the experimental group received Capitan's Log Cognitive Rehabilitation Software (2018) individually for 12 sessions of 50 minutes of training program, whereas the control group did not receive this training program. TOLD language development test was used to evaluate students' verbal skills. The collected data were analyzed using multivariate analysis of covariance SPSS 24. CCR led to enhanced ability of the experimental group subjects in the post-test and follow-up stages compared to the control group in terms of most of the verbal skills. ($p < 0.05$). However, there were no significant differences between the ability of the subjects of the experimental and control groups regarding producing the word in the post-test and follow-up stages ($p < 0.05$). The findings indicated that CCR program is effective in the development of students' verbal skills with SPLD and could be used as an appropriate intervention method.

Keywords: computerized cognitive rehabilitation, verbal skills, Specific Mathematical Learning Disorder

Introduction

Specific learning disorders are among the neurodevelopmental disorders at the early stages of education. These disorders are associated with lasting problems or deficits in learning basic academic skills like reading, writing, and math. One of these types of disorders is mathematical learning disorder that can be diagnosed with problems in numerical magnitude perception, memorization of arithmetic fact, accuracy and fluency calculation and accuracy in mathematical reasoning around 8 years of using academic performance tests and screening (American Psychiatric Association, 2013). Net News, LDA of Minnesota (Lemberg, 2011) admits that 6% of the student's experience learning disabilities in math. Another study has estimated that 5 to 8% of children aged 6-14 have a math disorder (Tengsujaritkul, Louthrenoo, & Boonchooduang, 2020).

Many studies have shown the presence of verbal problems in children with specific learning disorders (Garnett & Fleischner, 1987; Vocate, 2013). Children with specific learning disorder have few words storage limited to frequent and short words (Pennington & Lefly, 2001; Race, 2002; Snider, 1989). Moreover, restricted vocabulary, semantic problems like limited semantic knowledge and weakness in word classification in semantic categories as well as word retrieval problems have been widely reported in this group. These problems include slowing down and the accuracy in naming when face with stimuli and phonological problems (Vellutino, Fletcher, Snowling, & Scalon, 2004). In a study on the effective role of language processing and its flexibility in concepts

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Received: 02/09/2021
Accepted: 08/27/2021

necessary for the development of mathematics, Montis (2000) stated that, linguistic problems may affect the perception and processing of information. Thus, the students with specific learning disorders cannot organize and interpret their experiences as knowledge due to perceptual problems and poor processing, so they may not be able to think to learn mathematical concepts and abstractions because of language flexibility and linguistic problems. Berteletti, Prado, and Booth (2014) presented simple and difficult assignments and studied the brain while doing homework, concluding that during solving mathematical problems, the brain needs to constantly change two mechanisms from numerical structure to verbal structure. Moreover, they figured out that children with a math disorder were unable to make the transition to the verbal mechanism while solving the problem because of dysfunctions in the mechanism of numerical structure. Their brain scans revealed less brain activity in the verbal and numerical areas than in normal children (D'amico & Passolunghi, 2009). Evidence has suggested that children with math disorders use the numerical mechanism only for simple problems, whereas normal students are more active in verbal areas, showing that students with math problems have difficulties in solving problems in verbal-numerical processing (Berteletti, Prado, & Booth, 2014).

One of the most effective therapies for cognitive impairment is cognitive rehabilitation programs (Finn & McDonald, 2011). Cognitive rehabilitation therapy is based on principles of brain neural plasticity that include targeted exercises to improve various areas of cognition like attention, memory, language, and executive functions (Berteletti et al., 2014). There are two basic methods for cognitive rehabilitation: (1) the restorative method, where the mental disorders are improved by repeated exercises, and (2) the compensatory method, where adaptive and corrective strategies and tools, and environmental modification are used to compensate for performance despite on-going failures. These two techniques can be used together and can be elements of a comprehensive multidisciplinary rehabilitation program including other types of psychological, social, and rehabilitation therapy (Hayes, 2015). Based on the principle of malleability and brain self-healing, CCR creates stable synaptic changes in them with continuous excitation of less active areas in the brain (O'Connel et al., 2007). These programs could adjust the level of difficulty of the task from simple to difficult according to individual differences and create on-going cognitive challenges for the individual (Gaitán et al., 2013). CCR programs provide tools that can be used to help enhance basic mental processes important in high-level learning (Barlett, Vowels, Shanteau, Crow, & Miller, 2009). Regarding this issue, many studies, including Eack et al. (2013), Ashouri and Jalila Abkenar (2020), Asef (2018) and Radfar, Nejati and Fatehabadi (2016) have shown the effectiveness of cognitive rehabilitation on verbal intelligence, auditory perception and language skills of a wide range of clinical populations from children with hearing impairments to autism spectrum disorders, hyperactivity, and learning disabilities.

Captain's log software is designed as one of the most widely used programs to rehabilitate and improve cognitive functions. Using this program, one can enhance the mental abilities of individuals in various fields. This program has over 2000 various exercises for 20 cognitive skills to enhance the performance of people with ADHD, learning disorders, brain injuries, mental retardation and psychiatric disorders like schizophrenia, mood disorders and so on. In this program, both basic cognitive functions and excellent cognitive functions are simultaneously improved and upgraded. Hence, one can improve one's skills and abilities for learning and success in various areas of daily life, academic life and career (Kotkin & Fine, 2003). The hypothesis of this study is that cognitive rehabilitation affects the verbal skills of the students with specific mathematical learning disorder.

Method

The method was quasi-experimental with pre-test-post-test design with control group and follow-up period.

Participants

The population was all male students in the fourth grade of elementary school admitted to Learning Disabilities Training Centers in Karaj from October to March of the academic year 2019-2020. The sample was 40 people selected using simple random sampling. First, a list of all fourth grade elementary students admitted to each learning disability center (previously given according to the inclusion criteria for diagnosing SPLD) was prepared. The initial list included 229 people, all of whom underwent the Wechsler test, with all having normal IQ, ranging from 90 to 110. From among these fourth grade male students with SPLD, a sample of 145 people was selected using simple random sampling. The students at a very low or prosperous level in terms of socio-economic status were subsequently excluded. The number of people who were in the average level in terms of socio-economic status was 102 people. In the next step, 40 of them were selected using simple random sampling method and then randomly assigned to experimental and control groups.

The inclusion criteria were (1) mathematical grade stated as "need to try more" in the score-sheet of the first semester of the academic year 2019-2020, (2) the monthly class exams sore given by the teacher in the class being 2 standard deviations from lower than the grade point average, (3) the student having a severe problem or weakness in mathematics according to the report of the relevant teacher in the reference school, (4) the student having normal IQ in the range of 90 to 115 after performing the Wechsler (Wisc-R) intelligence test, (5) the student not suffering from weakness or acute and severe problems in other subjects, (6) and these students having no training or educational rehabilitation and being in the line of training after being admitted to learning disabilities training centers and definitive diagnosis of mathematical learning with the above criteria. In addition, the inclusion criteria for having a math learning disability according to the DSM-5 diagnostic criteria and key math were the presence of the child in the learning disability center, age range of 10 to 12 years, parent, and child and teacher satisfaction were necessary conditions to enter the study.

Exclusion criteria were (1) receiving another concomitant treatment plan, (2) having a disorder other than learning disability, (3) absenteeism more than 2 sessions, and (4) expressing reluctance to attend sessions.

The mean (and standard deviation) age of the experimental group was 10.85 (and 0.67) years and the mean (and standard deviation) age of the control group was 10.95 (and 0.68) years. Thus, 6 students of the experimental group were 10 years old, 11 were 11 years old and 3 were 12 years old. Moreover, 5 students of the control group were 10 years old, 11 were 11 years old and 4 were 12.

Instruments

Test of Language Development (TOLD): In this study, verbal skills were measured using TOLD. This test is one of the comprehensive tools in measuring children's language development, designed by Newcomer and Hammil (1998) and translated into Persian by Hassanzadeh and Minaei (2002). This test is based on a two-dimensional model which in one dimension there are linguistic systems with components of listening (receiving), organizing (compound-mediating) and speaking (expressive) and in the other dimension are the linguistic coordinates with semantic, syntactic and phonological aspects. The two-dimensional model mentioned above has 9 subtests, 6 subtests related to semantics and syntax, which are part of the main subtests, and 3 subtests related to phonological tests, which are part of the supplementary subtests. All three subtests evaluate the coding aspects used to produce meaningful speech. In each subtest, a score of one is given for each correct answer and zero for each incorrect answer (Pirooz, Amiri, & Kajbaf, 2009). According to the test manual, alpha coefficients for all individuals were obtained through the mean alpha coefficients of different age levels using the z conversion method. The alpha coefficient for subtests and combinations was very good. The high coefficients show that the test is a very reliable test and its results can be used with confidence. Mean alpha coefficients in the subtests of visual vocabulary, relational vocabulary, oral vocabulary, grammatical comprehension, sentence imitation, grammatical completion, word differentiation, phonological analysis and word production were, respectively, 0.76, 0.89, 0.89, 0.74, 0.90, 0.81, 0.90, 0.94 and 0.82 (Sobhani Rad, Moghimi, Chamanabad, & Marouzi, 2013). In this study, the reliability of this scale was calculated using Cronbach's Alpha, Spearman-Brown and Gutmann methods. Cronbach's alpha coefficient for the whole test was 0.86 and from 0.61 to 0.83 for its subscales. Spearman-Brown split-half coefficients were 0.88 for the whole questionnaire and from 0.69 to 0.91 for its subscales. Moreover, Guttman correlation coefficients were 0.83 for the whole questionnaire and from 0.64 to 0.89 for its subscales. Moreover, in the present study, the content validity ratio of the TOLD, evaluated by 10 experts from the Learning Disabilities Educational Centers in Karaj, was obtained from 0.71 to 0.92 for its subscales.

Wechsler Intelligence Scale for Children-Fifth Edition (WISC-V): One of the most complete tests to measure different IQ scales and a comprehensive clinical tool for evaluating the intelligence of children aged 6-16 years and 11 months. The fifth version was introduced in 2014. WISC-V has 10 main subtests, six secondary subtests, and five supplementary subtests. By studying the construct validity of WISC-V, Canivez, Watkins, and Dombrowski (2017) estimated the omega-hierarchical coefficient of the main subtests and overall IQ as high and sufficient (0.82). The test has been adapted and standardized on a sample of Iranian children by Mousavi Sadaati et al. (2019). The validity of the subtests in the retest ranged from 0.65 to 0.95 and the split-half validity coefficients of it have been reported from 0.71 to 0.86. WISC-V has been used in the study to determine the IQ and basic cognitive processes in children with math learning disabilities (sample) who are weak at them. WISC-V validity was obtained by content validity and predictive validity as 0.61-0.79 and by examining the correlation between WISC-V subtests as 0.56-0.84. Furthermore, the reliability of the test in the study was obtained using Cronbach's alpha, Spearman-Brown, and Guttmann Split-half methods and the reliability coefficients were 0.81, 0.89, and 0.88, respectively.

KeyMath-3 Diagnostic Assessment: This test is used to determine the students with learning disabilities in mathematics. This math test that was developed by Connolly in 1988 is a reference criterion test with rules for normative interpretation that has three basic concepts, operations, and application in terms of subject matter and sequence. Mohammad Ismail and Hooman (2002) standardized this test nationally for 9- to 12-year-old students. The reliability of the test was estimated using Cronbach's alpha method and in 5 elementary grades as 0.80-0.86 and its validity was 0.50-0.97 using content validity, discriminant validity, predictive validity, and simultaneous validity. Cronbach's alpha, Spearman-Brown, and Guttmann Split0half methods have been used in the study to determine the reliability of the Iran keymath test. Cronbach's alpha coefficients in the subtests ranged from 0.75 to 0.86 and overall, 0.89, in Split0half method the reliability coefficients for the subtests ranged from 9.76 to 0.89 and overall, 0.90. Moreover, the validity of the Iran keymath test in this study was calculated using discriminant validity and predictive validity (prediction of students' mathematical scores by the test) and obtained as 0.61-0.72.

Captain's Log Cognitive Software Program: In this study, spatial-visual and problem-solving skills were presented by the exercises of this software. Captain's Log was first introduced in 2000 by Brain Train Company in America. This training package is for the promotion of excellent cognitive functions and processes. Captain's Log evaluation system can evaluate a person in 9 areas of cognitive functions and suggest a training program according to the individual's situation. Besides this ability, any exercise that a person does from the beginning and in the early stages of homework, basic skills are practiced and the person practices various skills according to a specific structure that becomes harder to fit the tasks and the skill level differs. In a study of 81 students with a mean age of 8 to 12 years with a working memory deficit, Pumaccahua, Wong, and Weist (2017) concluded that the application of Captain's Log cognitive rehabilitation software could enhance the working memory (spatial-visual working memory) of these students.

Procedure

Forty samples were selected using simple random sampling method and randomly divided into two groups of 20 people (20 in experimental group and 20 in the control group) after performing the following. To this end, Wechsler IQ test was performed, students were adapted to the diagnostic criteria for SPLD, Iran keymath test was performed and definitive diagnosis was conducted, and the consent of students and their parents to participate in the study was obtained. The 20 subjects in the control groups did not receive any special intervention or training, except for the regular training provided by the schoolteacher in the classroom as they were waiting for a training class. To facilitate the training, 20 people in the experimental group were divided into 4 groups and received 50minutes of therapeutic-educational intervention in 12 sessions using Capitan's log cognitive rehabilitation method. Training sessions were held for each group for 12 days. It took 4 weeks to train the experimental group, including the post-test. It has to be noted that to control the effect of training different educators in the way of providing intervention, all trainings were performed by the researcher during the training period for all groups tested. Moreover, the parents were given homework to do some of the exercises provided at the end of each training session.

The Capitan's log program was first introduced in 2000 by Brain Train Co., in the United States. This training course was conducted in 12 sessions for 50minutes twice a week. During these sessions, the exercises and cognitive skills of executive functions, processing speed, problem solving and spatial visual ability were performed in the form of computer exercises, in a systematic way (if progress is made in one stage, permission is granted to enter another stage, whose exercises are harder).

Findings

Table 1 separately shows the descriptive indices of executive functions and problem soving in the pre-test, post-test and follow-up stages for the experimental and control groups.

Table 1.
Mean and Standard Deviation of Verbal Skills Separately for the Experimental and Control Groups in Three Measurement Stages

Variable		Group	Measurement stage					
			Pre-test		Post-test		Follow-up	
			Mean	SD	Mean	SD	Mean	SD
Verbal skills	Visual vocabulary	Experiment	12.35	1.14	13.30	1.13	13.30	1.22
		Control	12.20	1.40	12.05	1.47	12.15	2.00
	Relational vocabulary	Experiment	11.20	1.06	12.60	0.68	12.85	0.81
		Control	11.75	1.16	11.50	0.95	11.35	1.09
	Oral vocabulary	Experiment	10.85	0.99	12.80	0.89	12.60	0.75
		Control	11.20	0.77	11.45	1.00	11.20	0.95
	Grammatical understanding	Experiment	9.00	0.79	10.70	0.92	10.45	0.83
		Control	9.25	0.79	9.45	0.94	9.30	0.73
	Sentence imitation	Experiment	8.05	0.76	10.50	1.24	10.25	0.97
		Control	8.35	0.81	8.85	1.04	8.50	0.83
	Grammatical completion	Experiment	11.45	0.89	12.40	1.23	12.15	1.18
		Control	10.95	1.05	11.30	0.73	11.20	0.83
	Word differentiation	Experiment	7.35	1.18	9.40	0.94	9.15	0.93
		Control	7.80	1.51	8.25	1.65	7.90	1.86
	Phonological analysis	Experiment	9.40	0.82	10.45	1.10	10.55	0.94
		Control	9.15	1.14	9.35	0.86	9.15	0.99
	Word production	Experiment	9.30	0.73	10.30	0.86	10.10	0.97
		Control	9.15	0.81	9.45	0.76	9.25	1.52

An overview of Table 1 indicates that with the measures taken after the training program with Captain's Cognitive Rehabilitation Software (2018 edition) among the students with SPLD of the experimental group, the mean scores of the following have increased as measures of verbal skills from pre-test to post-test: visual vocabulary, relational vocabulary, oral vocabulary, comprehension, grammar, sentence imitation, grammar completion, word differentiation, phonological analysis, and word production. These changes in the mean scores of the verbal skills measures of the experimental group students remained somewhat stable after two months in the follow-up phase. However, the mean scores of the verbal skills measures of students with special disabilities of the control group did not change much from pre-test to post-test and follow-up. Although these conclusions are inferences without statistical testing, more detailed subsequent studies will reveal the significant differences in pre-test, post-test and follow-up of experimental and control groups.

Prior to performing the multivariate analysis of covariance, Kolmogorov-Smirnov test was used to examine the normality of the distribution of scores between the two groups regarding the variables, the results of which are given in Table 2.

Table 2.
Data. Smirnov-Kolmogorov Test Results to Determine the Normality of the

Variable	Pre- test		Post-test	
	Ssig	Kolmogorv –Smirnov Z	Sig.	Kolmogorov –Smirnov Z
Visual vocabulary	0.147	.200[c,d]	0.188	.061[c]
Relational vocabulary	0.176	.107[c]	0.181	.086[c]
Oral vocabulary	0.173	.117[c]	0.194	.048[c]
Grammatical understanding	0.171	.127[c]	0.177	.099[c]
Sentence imitation	0.182	.082[c]	0.157	.200[c,d]
Grammatical completion	0.187	.065[c]	0.182	.080[c]
Word differentiation	0.166	.148[c]	0.180	.087[c]

Variable	Pre- test		Post-test	
	Ssig	Kolmogorv –Smirnov Z	Sig.	Kolmogorov –Smirnov Z
Phonological analysis	0.178	.098[c]	0.176	.105[c]
Word production	0.145	.200[c,d]	0.163	.175[c]

Also Levene's test was used to examine the homogeneity of variances of the variables and Box M test to examine the homogeneity of variance-covariance matrices where the results were insignificant (p> 0.05). Moreover, Bartlett's test of sphericity was used to test the default correlation of scattering variables or pre-tests with each other where with the significance of KMO index and the chi-square calculated for Bartlett's test of sphericity (p <0.05), one can state no multiple colinearity between the scattering variables and the correlation of the scattering with each other is normal. Hence, the data did not question the assumptions of using analysis of covariance. Thus, given the observance of the assumptions, the analysis of covariance can be used.

A multivariate analysis of covariance was performed on the data to compare the experimental and control groups based on the post-test scores and to follow up the verbal skills after controlling the effect of the pre-tests, the results of which are given in Table 3.

Table 3.
Multivariate Analysis of Covariance on Post-Test Scores of Verbal Skills of Experimental and Control Groups

Effect	Value	Hypothesis df	Erorr df	F	Sig.	Effect size
Pillai's Trace	0.86	9	21	14.86	0.001	0.86
Wilk's Lambda	0.14	9	21	14.86	0.001	0.86
Hotelling's Trace	6.36	9	21	14.86	0.001	0.86
Roy's Largest Root	6.37	9	21	14.86	0.001	0.86

The significance level of all multivariate tests for verbal skills (p <0.01 and F = 14.86) in the post-test stage with pre-test control and significance level of all multivariate tests for verbal skills (p <0.01 and F = 17.23) in the follow-up stage was obtained by controlling the pre-test less than 0.01. Hence, the zero hypothesis is rejected and a significant difference between the verbal skills of the experimental and control groups is determined in post-test and follow-up. The effect test between the subjects was used to examine the differences between the experimental and control groups in each of the verbal skills, the results of which are given in Table 4.

Table 4.
Intra-subject Effects of Post-Test Comparison and Follow-Up of Groups' Verbal Skills by Controlling Pre-Test

Variable		Post-test			Follow up		
		F ratio	Sig.	Effect size	F ratio	Sig.	Effect size
Verbal skills	Visual vocabulary	16.57	0.001	0.36	7.18	0.012	0.20
	Relational vocabulary	23.94	0.001	0.45	26.37	0.001	0.48
	Oral vocabulary	23.10	0.001	0.44	20.99	0.001	0.42
	Grammatical understanding	13.86	0.001	0.32	21.45	0.001	0.43
	Sentence imitation	11.31	0.002	0.26	24.92	0.001	0.46
	Grammatical completion	5.82	0.022	0.17	4.39	0.045	0.13
	Word differentiation	5.24	0.030	0.15	8.88	0.006	0.24
	Phonological analysis	8.16	0.008	0.22	22.97	0.001	0.44
	Word production	2.46	0.127	0.08	2.41	0.132	0.08

Based on the results in Table 4, there was a significant difference (p <0.05) in terms of post-test by controlling the pre-test between the experimental and the control groups in terms of most of the verbal skills, including visual vocabulary, relational vocabulary, oral vocabulary, grammatical comprehension, sentence imitation, grammatical completion, word differentiation and phonological analysis (p<0.05). However, no significant difference was observed between the ability to produce the word of the subjects of the experimental and control groups in the post-test and follow-up stages ($p < 0.05$). Moreover, the results presented in Table 2 showed that by controlling the pre-test between the experimental group and the control group in terms of following up, most of verbal skills including visual vocabulary, relational vocabulary, oral vocabulary, grammatical comprehension, sentence imitation, grammatical completion, word differentiation and phonological analysis have a significant difference ($p < 0.05$); but no significant differences were observed between the ability of subjects in word production in the experimental and control groups in the post-test and follow-up stages ($p < 0.05$).

Discussion

The purpose of this study was to determine the effectiveness of CCR on verbal skills of students with SPLD. The results revealed that CCR improves the performance of students with SPLD in many verbal skills, including visual vocabulary, relational vocabulary, oral vocabulary, grammatical comprehension, sentence imitation, grammatical completion, word differentiation and phonological analysis. This is overall in line with the results of Eack et al. (2013), Ashouri and Jalil Abkenar (2020), Asef (2018) and Radfer, Nejati, and Fatehabadi (2016) showing that cognitive rehabilitation is effective in verbal intelligence, auditory perception and language skills in a wide range of clinical populations of children with hearing impairments to autism spectrum disorders, hyperactivity, and learning disabilities. For explaining the effect of CCR on verbal skills, one can state that the Capitan's log cognitive rehabilitation program can increase verbal-related executive functions among the children with SPLD, as it teaches orientation, response inhibition, multistage commands, and auditory and visual memory.

Teaching the steps of orienting and working with the mouse and teaching the auditory and visual memory of one item to several items can strengthen the working memory of these children. Moreover, as verbal skills and working memory are closely related to each other as components of executive functions, doing verbal psychological homework not only depends on language skills related to phonological and semantic cognition, but also needs the involvement of important cognitive abilities like executive functions (cognitive processes that integrate and control other cognitive activities) and working memory (temporary retention of information in the mind for immediate access to them) (Radfer et al., 2016). Thus, given the intertwined relationship between verbal skills, working memory and executive functions, strengthening working memory and executive functions apart from CCR exercises, like strengthening attention and memory, improves verbal skills.

What is evident is that cognitive rehabilitation in the present study led to improvement in the executive functions associated with verbal skills in students with SPLD. Another reason for this result could be that cognitive rehabilitation interventions could enhance working memory and increase brain activity in the prefrontal cortex. Indeed, rehabilitation can stimulate areas in the brain that are related to executive functions. As the students with SPLD face dysfunction of the frontal lobe and on the other hand this part of the brain is responsible for the executive functions of the brain, cognitive rehabilitation improves working memory (Rodríguez-Blanco, Lubrini, Vidal-Mariño, & Ríos-Lago, 2017). By improving working memory, more space is provided for storing verbal and non-verbal information of the problem and retrieving mathematical facts and required processes and methods. It also facilitates the processing that converts information into numerical output. Thus, with the improvement of working memory, it is expected that the student's verbal and mathematical performance of the students with SPLD improve.

Overall, given the brain pathways involved in computer cognitive tasks (Ciesielski, Lesnik, Savoy, Grant, & Ahlfors, 2006), it seems that computer cognitive rehabilitation well involves the brain areas related to working memory - the executive functions related to students' verbal skills - of the students with SPLD. This is because of various visual and audio stimuli and by simultaneously involving sensory areas (for processing sensory inputs), the cortex (to process the complexities of the task and choose the appropriate strategy to respond to the task) and finally the motor areas (to issue a motor feedback). Involvement and activation of working memory brain areas is especially effective when the task involves an emotional aspect of success (immediate reward) or failure (failure to progress to the next level).

Conclusion

The findings indicated that CCR led to enhanced ability of the experimental group subjects in the post-test and follow-up stages compared to the control group in terms of most of the verbal skills like visual vocabulary, relational vocabulary, oral vocabulary, grammatical comprehension, sentence imitation, grammatical completion, word differentiation and phonological analysis. However, there were no significant differences between the ability of the subjects of the experimental and control groups regarding producing the word in the post-test and follow-up stages. Computerized Cognitive Rehabilitation program is effective in the development of students' verbal skills with Students with Mathematical Learning Disorder and could be used as an appropriate intervention method.

The study had some limitations, like the limitation of time and place suitable for conducting exams and training in official hours. Because of these limitations, continuing the program in more sessions could bring about greater effectiveness. Other researchers are recommended to conduct similar studies and study the effect of computer-based cognitive training on other skills affecting mathematical learning like the ability to estimate, interpret data, and so on. It is recommended to conduct studies on a larger scale for male and female students of various ages and educational backgrounds, use other diagnostic tests, and implement intervention programs to prevent more serious problems in the higher academic years. Moreover, it is recommended that computer cognitive programs be taught for other learning problems and the results be examined.

Acknowledgements

This paper was financially supported by Cognitive Sciences and Technologies Council. We appreciate the participation of all the children and their families who attended this study with motivation, also express our gratitude to all teachers and managers of Learning Disabilities Training Centers in Karaj.

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How to Site: Esmailzadeh Roozbahani, A., Behroozi, N., Omidian, M., & Maktabi, G. (2021). The Effect of Computerized Cognitive Rehabilitation (CCR) on verbal skills of the students with mathematical learning disorder. *Iranian Journal of Learning & Memory*, *4*(13), 38-46. Dor: 20.1001.1.26455455.2021.4.13.4.4