Journal of Rehabilitation Sciences and Research

Journal Home Page: jrsr.sums.ac.ir

Original Article

The Effect of Cognitive Rehabilitation on the Improvement of Language Skills in 9-12 Years Old Children with Attention Deficit/ Hyperactivity Disorder

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ARTICLE INFO

Article History:
Received: 12/03/2018
Revised: 11/04/2018
Accepted: 18/04/2018

Keywords:
Attention-deficit/hyperactivity disorder
Cognitive rehabilitation
Naming
Reading abilities
Verbal fluency

ABSTRACT

Background: According to the research literature, there was a relationship between cognitive functions of attention and working memory and linguistic skills. The aim of this research was to investigate the effect of cognitive rehabilitation on the improvement of the linguistic skills in 9-12 years old children with attention-deficit/hyperactivity disorder.
Methods: 40 students in grade 4, 5 and 6 of a primary school in Miyane city were assigned equally and randomly to two intervention and control groups. The research design was experimental with pre-test, post-test, follow-up, and control group. The language tests included; Thurston Verbal Fluency task, Token test of receptive language, Boston naming speed test, Assessment of Persian Reading Ability (APRA), verbal working memory subtest of Wechsler Intelligence Scale for Children, and Attention Register task. Parental version of the Swanson, Nolan, and Pelham (SNAP-IV) questionnaire was used to screen ADHD. The intervention method was based on Attentive Rehabilitation of Attention and Memory (ARAM) with emphasis on attention and working memory. Mixed ANOVA statistical test was used to analyze the data.
Results: The results showed that the linguistic skills assessed in the research which include naming (F=29.42, P=0.01), verbal fluency (phonological fluency: F=15.68, P=0.01; semantic fluency: F=13.73, P=0.01), reading abilities (alphabet reading 1: F=17.84, P=0.01; alphabet reading 2: F=27.07, P=0.01; word reading: F=19.82, P=0.01; reading ability: F=19.97, P=0.01; voice change: F=13.47, P=0.01; reading comprehension: F=36.85, P=0.01), comprehension (F=6.75, P=0.01), verbal working memory (direct digits: F=7.7, P=0.01; inverse digits: F=14.26, P=0.01) and attention (attention registration 1: F=10.23, P=0.01; attention registration 2: F=4.33, P=0.04) were improved, following the intervention.
Conclusion: Computerized Training of working memory and attention can enhance the language skills in children with ADHD. This result confirmed the role of attention and working memory on language skills.

Introduction

Attention Deficit/Hyperactivity Disorder (ADHD) is the most common neurobehavioral disorder in childhood [1]. Co-morbidity of ADHD is very high with linguistic problems; such that the speed of naming in children with ADHD is slower than typically developing (TD) children [2] and their performance is weaker in naming tasks [3]. Also, children with ADHD are weaker in verbal fluency tasks [4]. Verbal memory is also weaker than TD children in the ADHD disorder [5]. Children

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with ADHD get lower scores in their receptive language tasks than TD children [6]. Also, the weakness in the ability of reading in children with ADHD compared to TD children was confirmed in several studies [7, 8]. The study by Alderson et al. [9] found that the episodic buffer in the working memory of children with ADHD was weaker than TD children, and especially their weaknesses were longer when the phonemic stimulus was audibly presented. But the most significant difference between children with ADHD and TD children was in the central executive. One of the most important roles of working memory is language learning and vocabulary development. Phonological loop as a part of working memory facilitates new vocabulary acquisition and availability of new words [10].

One of the therapeutic interventions that were considered in the field of children with neurodevelopment disorders and that was expected to be effective in improving linguistic skills of children with ADHD, is cognitive rehabilitation [11, 12]. Cognitive rehabilitation is described as a process that improves the functions and quality of life of people who are experiencing cognitive and perceptual defects in their daily lives, which is used to improve the cognitive capacities of exercises and provide goal-directed stimuli [13]. Kessler et al. [14] examined the effect of cognitive rehabilitation on executive functions and pointed out that cognitive rehabilitation program significantly improved the processing speed, cognitive flexibility, the scores of verbal and visual memory and also the activity enhancement of the prefrontal cortex. Kim et al. [15] stated in a study that cognitive rehabilitation interventions had improved the memory and attention of these subjects. Training of executive functions is a part of cognitive rehabilitation components that includes memory and attention exercise.

Various studies have investigated the effect of cognitive rehabilitation on a wide range of difficulties such as ADHD [16] brain injury [17], executive functioning deficits [14], working memory and selective attention [15, 18], language comprehension [19] and Schizophrenia [20]. So, in children with ADHD, the main symptoms of cognitive deficits in a variety of attention such as sustained attention, divided attention, shifting attention and executive functions, working memory and impaired inhibitory control; we use tasks which lead to the strengthening of the attention types, executive functions, working memory, and inhibitory control [21].

Given that there is evidence of the effect of cognitive rehabilitation on psychological problems, as well as deficiencies in executive functions and linguistic skills in children with ADHD and the effect of linguistic problems on the behavioural and cognitive abilities of children with ADHD, this research was focused on the effect of cognitive rehabilitation on linguistic skills in children with ADHD. One of the novelties of this research was that it was the first study in Iran that a cognitive rehabilitation implemented to enhance language skills. Another novelty of this study was that we considered a comprehensive number of language skills and test to language assessment whereas the similar studies were considered a limited number of language skills. Therefore, the present research hypothesis was thus; performing cognitive rehabilitation intervention based on working memory and attention can improve the performance of children with ADHD in linguistic variables such as verbal fluency, naming, comprehension, reading and verbal memory.

Methods

The statistical population of this study was the male and female students of the fourth, fifth and sixth grade of the elementary school in the city of Miyaneh. The sampling method was the convenience sampling and the sampling process was carried out in several steps. At first, we referred to the schools and we requested the school principals to identify students suspected of having ADHD symptoms. In total, 262 students were identified as suspected students. Then the parents of the students were contacted and the ADHD questionnaire was completed by their mothers. 130 students with a score above the cut-off point score (25/54) were referred to the psychiatrist, 90 of whom were diagnosed with ADHD. Of these students, 40 with gender and age matching, randomly (by Microsoft Office Excel random number generator) assigned to case and control groups and the other 50 children role out because sample size estimation and power analysis using G*Power software (α=0.05, power=0.80, effect size f=0.47) confirmed that at least 19 participants for each group was enough and we considered 20 participants for each group. The follow-up was executed 3 months after post-test using the same tests. The intervention was performed in 16 sessions (2 sessions in a week) for 8 weeks in speech therapy clinic.

The verbal fluency task (Thurston, 1983) [22] is a very useful test for evaluating executive and linguistic skills and it consists of two sub-scales: 1) Semantic fluency and 2) Phonological fluency. Amy and Takashi studied the psychometric properties of this test and recognized the internal consistency of both parts of the test using the Cronbach's alpha coefficient equals 0.81. A significant correlation between verbal fluency task with Stroop and Recalling Sentences confirmed the validity in an Iranian study [23]. For semantic fluency examination, the meaning of two sub-tests is the name of the animal and the name of the fruit. Subjects were asked to indicate any number of names of fruits and animals in 60-second duration respectively. Finally, the number of named names was recorded as a test score. In the phonological fluency section, participants must write in words of "F" and "J" in two distinct 60-second intervals. In this section, the number of words was also recorded as test scores [22].

To test the abilities of receptive and comprehensive linguistic abilities, the Token Test was used to test the abilities. This test was traditionally designed to evaluate Aphasia. The Token Test was first introduced by Renzi and Vignolo in 1962 and was later developed by Boller and Vignolo in 1966. The test included 62 commands. It consisted of 20 plastic marks in 5 colors (red, white, yellow, blue and green) and two sizes (small in diameter of approximately 2 centimetres, large in diameter of approximately 3 centimetres) and two shapes (circle and square-square). It was arranged in front of the subject in a fixed order. The characters were presented to the individual and questions were asked. The test took about 10 minutes. A score was assigned to each part of the question that was processed correctly. The age or educational level was not as effective. The maximum score was 163 [24]. Test-retest reliability reported 0.91 and 0.98 for this test [25].

Direct and inverse digit span tests were among the tests that were widely used to measure verbal memory [26]. In this research, the subscales of digit span of the third edition of the Wechsler Intelligence Scale for Children were used to evaluate verbal memory. Test-retest reliability reported 0.81 and 0.62 for direct and inverse digit span respectively [27].

The Boston Naming Speed Test was used to assess the naming ability. Before completing any part, the participant became familiar with the test by first taking an example. In this test, a number of pictures were shown to the child who was asked to name it. The child should call each part of the test aloud. The time of naming a child after each part of the test was recorded and the duration of the child's naming was considered as the child's score in the naming speed test [28]. Test–retest reliability of the test ranged from r = 0.59 to 0.92 and it correlated highly (r=0.76 to 0.86) with other naming tests, such as the Visual Naming Test from the Multilingual Aphasia Examination [29].

To evaluate reading ability, in this study, the Assessment of Persian Reading Ability (APRA) test was used. This test was carried out during the study of PourEtemad and Jahani [30] about 1500 primary school students in Qom and its psychometric properties were evaluated. The reading test contained 11 Persian texts and the card number 1 was a practice card. Each grade had two cards and the first text of each grade was a story that was taken from the stories of the "Neal Analyses of Reading Ability" and based on the dictionary of Persian books of each grade, the rewriting, face and content validity of which was confirmed through the comment of some of the teachers of the first, second, and third grades. The second text of each grade was adapted from the textbooks, and in order to reduce the effect of previous prescriptions in the subject's current practice, several words or phrases in each text with words or phrases in each text were replaced by other terms or phrases, and these words or phrases were also derived from the Persian Book of the same and according to a teacher survey, it was revised twice and was finally selected as the most appropriate text. In the text reader, the time was considered. The condition for placing the second card in each grade was that the subject on the card number one of the corresponding grade had no more than 24 false points. If the word was false (except for parsing and retrieving) one score was given and the time spent was as well calculated at the end [30]. This test consists of six sub-scales: 1) Alphabet reading 1, 2) Alphabet reading 2, 3) Word reading, 4) Reading ability, 5) Sound change, and 6) Reading comprehension.

Attention register task was used to measure attention deficit. This test was designed to measure attention deficit that was based on Persian language and letters. There were 14 lines in this test, consisting of letters C, B, T, and P with vowels. 4 letters were given as a sample at the top of the page and the participants were expected to find the letters similar to the letters on the page and draw a line around them. The name of this test was also called the registration of attention due to the fact that the individual's attention is given to the individual's attention and the use of the letters C, B, and T. The concurrent validity of this test with valid tests of continuous attention for the omission error index was 0.479. The three variables can be extracted from this variable: (1) the omission error: the number of targets lost, (2) the commission error: the number of non-targets that were mistakenly identified as the target, and (3) the time: the duration (with seconds) of doing the test [31].

For the evaluation of ADHD, the fourth version of the Parental version of the Swanson, Nolan and Pelham (SNAP-IV) questionnaire was used. The questionnaire is an ADHD screening tool designed for children and adolescents aged 7 to 12 years old. The questionnaire had a parental version of 18 questions, 9 of which were considered for attention deficit type; the other 9 evaluated hyperactivity type, and the total of 18 evaluated the mixed type of ADHD. The reliability of this test in an Iranian research using Cronbach's alpha coefficient was 0.90. Using split-half method gave a result of 0.81 and using test-retest resulted to 0.76 and a criterion validity of 0.48. Minimum and maximum scores in this scale were 0 and 54 respectively. The cut-off score of this scale was 25 and the scores above the cut-off score receive ADHD diagnosis [32].

Cognitive rehabilitation was carried out using a cognitive rehabilitation program called the Attentive Rehabilitation of Attention and Memory (ARAM). This program is a kind of software designed to enhance the cognitive abilities created by Nejati [33] and in some reports, its effectiveness was shown on executive functions. The program included a group of organized hierarchical tasks that enhanced the various dimensions of attention (selective, sustained, shifting, and divided) and working memory. These practices are hierarchical. This means that the therapist records the information obtained from the evaluation of the sessions, including the percentage of the correct responses of the client and task completion speed. If the client masters a task, the therapist increases the difficulty level of the task [21]. Training on how to enhance executive functions at the Cognitive Behavioural Sciences and Research Centre was studied under the supervision of the supervisor. The basics of this program include: 1) Tasks are organized in hierarchy and become difficult to answer based on user responses. 2) Correct performance of the task will be immediately rewarded and the rewards gradually presented with delay. 3) The tasks based on executive functions are designed. 4) The tasks are enjoyable and are presented with emotional stimuli to enhance the subject's motivation to perform. 5) Assignments can be repeated until the subject reaches the desired level. 6) The decision of the program's progress is based on the performance of the participant and the presence of the therapist is required to improve the level of the task [33] (Figure 1).

Results

16 female (age: mean±SD, 10.75±0.68) and 24 male (age: mean±SD, 10.83±0.81) students participated in this research. Descriptive findings and central indicators of variables in the research were presented in three stages: pre-test, post-test and follow up with two groups of intervention and control group (Table 1).

To examine the difference between the participants in the control group and the intervention group, a mixed analysis of variance was used in the pre-test, post-test and follow-up testing. For this purpose, the grouping of the participants as the between-subject and the scores of the three stages of the testing as the within-subject variable

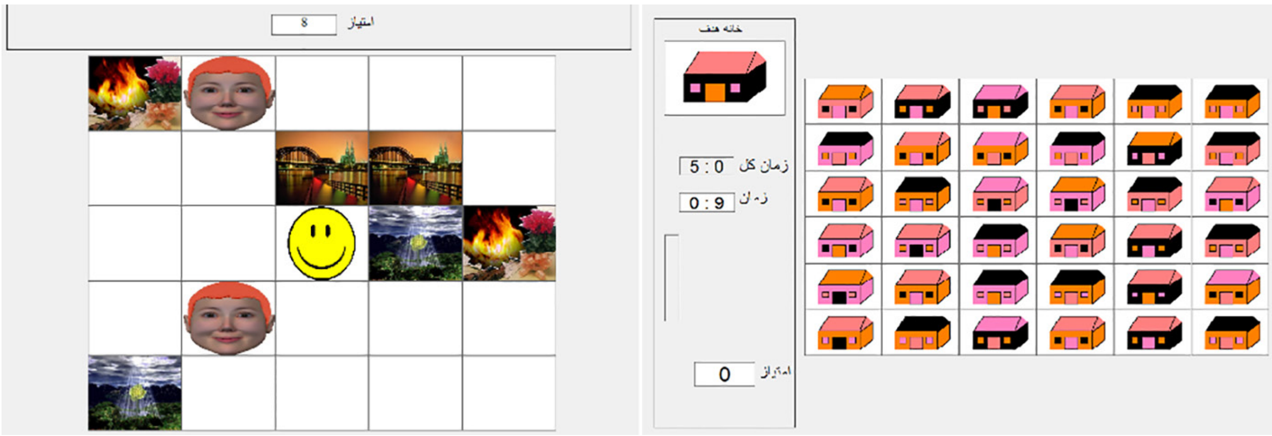

Figure 1: Attentive Rehabilitation of Attention and Memory (33)

Table 1: Descriptive statistics

Variables	Group	N	Pre-test	Post-test	Follow-up
			Mean±SD	Mean±SD	Mean±SD
Phonological fluency	Intervention	20	17.15±4.63	25.25±4.71	24.95±4.19
	Control	20	17.70±7.43	16.55±3.73	16.70±3.73
Semantic fluency	Intervention	20	19.10±5.08	24.95±4.78	24.6±4.75
	Control	20	16.70±7.01	16.50±6.06	16.45±5.79
Comprehension	Intervention	20	91.25±30.22	125.80±21.98	129.45±18.92
	Control	20	93.00±36.65	90.85±33.89	91.00±33.71
Direct digits	Intervention	20	3.10±0.64	3.60±0.60	3.35±0.74
	Control	20	2.95±0.60	2.80±0.62	2.85±0.59
Inverse digits	Intervention	20	1.75±0.72	2.90±0.64	2.65±0.67
	Control	20	1.80±0.77	1.70±0.66	1.75±0.63
Attention registration 1	Intervention	20	30.50±14.87	10.20±4.50	9.45±4.37
	Control	20	30.80±20.45	31.65±19.87	30.15±16.14
Attention registration 2	Intervention	20	9.70±10.43	4.00±3.21	3.40±2.62
	Control	20	10.75±10.24	10±8.92	9.75±7.05
Attention registration time	Intervention	20	1254.55±417.62	1225.2±312.03	1312±317.01
	Control	20	1260.85±442.85	1249.25±431.96	1239.35±430.54
Naming	Intervention	20	262.65±21.01	331.20±9.75	330.80±10.81
	Control	20	271.10±31.01	269.50±272.45	28.14±272.45
Naming time	Intervention	20	997.80±410.19	1002.1±410.11	991.65±403.7
	Control	20	896.80±515.33	901.6±500.52	893.70±493.12
Alphabet reading 1	Intervention	16	17.31±6.68	30.81±5.42	30.81±5.42
	Control	15	16.87±7.23	16.88±7.07	16.88±7.07
Alphabet reading 2	Intervention	16	16.31±12.57	46.13±12.71	46.13±12.71
	Control	15	15.33±11.08	15.19±10.78	15.19±10.78
Word reading	Intervention	16	7.69±2.30	13.75±2.11	14.31±2.06
	Control	15	8.53±2.97	8.44±2.85	7.75±2.18
Reading ability	Intervention	16	130.69±30.32	204.63±36.08	206.94±34.09
	Control	15	130.80±36.17	128.81±36.06	122.19±26.27
Sound change	Intervention	16	1.69±1.14	3.81±1.28	3.62±1.08
	Control	15	1.93±0.59	1.94±0.57	1.94±0.57
Reading comprehension	Intervention	16	4.31±2.33	10.94±2.69	11.63±2.47
	Control	15	4.73±1.83	4.56±1.90	4.13±1.31

were entered in the equation and the LSD post hoc test was conducted for three stages of testing. Considering that the reading test for the sixth-grade students was not performed, the combined analysis of variance was done twice; for all tests except for reading subscales and once again for reading subscales. Mixed variance analysis of all variables showed that the results of the Mauchly's Test of Spheri city for all variables were significant at the level of P=0.001, hence the Greenhouse-Geisser correction was used (Table 2).

The between-group analysis revealed that the main effect of the group in all research variables was significant, except for the time of attention and time of naming, meaning that the two groups had a significant difference in the variables (Table 3).

From the table above, the main effect of the testing on all variables, other than attention time and naming time, was significant. This effect means that there was a significant

Table 2: Between-group effects

Source	Variable	Type III Sum of Squares	df	F	Sig.	Partial Eta Squared
Group	Phonological fluency	896.53	1	15.68	0.01	0.29
	Semantic fluency	1203.33	1	13.73	0.01	0.26
	Comprehension	17112.41	1.00	6.75	0.01	0.15
	Direct digits	7	1	7.7	0.01	0.17
	Inverse digits	14	1	14.26	0.01	0.27
	Attention registration 1	6006.68	1.00	10.23	0.01	0.21
	Attention registration 2	598.53	1	4.33	0.04	0.1
	Attention registration time	10716.3	1	0.24	0.87	0.01
	Naming	41515.20	1.00	29.42	0.01	0.44
	Naming time	298901	1	0.47	0.49	0.01
	Alphabet reading 1	2033.48	1.00	17.84	0.01	0.38
	Alphabet reading 2	10143.92	1.00	27.07	0.01	0.48
	Word reading	320.83	1.00	19.82	0.01	0.41
	Reading ability	63219.27	1.00	19.97	0.01	0.41
	Sound change	28.53	1	13.47	0.01	0.31
	Reading comprehension	463.96	1.00	36.85	0.01	0.56

Table 3: Within-group effects

Source	Variable	Type III Sum of Squares	df	Mean Square	F	Sig.	Partial Eta Squared
Assessment time	Phonological fluency	315.21	1.11	282.64	21.08	0.01	0.35
	Semantic fluency	198.81	1.2	165.71	25.81	0.01	0.57
	Comprehension	7915.46	1.10	7168.63	51.00	0.01	0.57
	Direct digits	0.61	1.91	0.32	2.08	0.13	0.05
	Inverse digits	6.21	1.84	3.36	14.82	0.01	0.28
	Attention registration 1	2847.51	1.28	2215.54	35.68	0.01	0.48
	Attention registration 2	318.71	1.39	227.96	7.57	0.01	0.16
	Attention registration time	20468.71	1.25	16355.14	1.05	0.32	0.03
	Naming	31063.51	1.48	20989.59	175.09	0.0	0.82
	Naming time	1683.65	1.25	1339.29	0.84	0.38	0.02
	Alphabet reading 1	959.32	1.00	959.32	59.30	0.000	0.67
	Alphabet reading 2	4566.79	1.00	4566.79	85.21	0.000	0.75
	Word reading	176.37	1.59	111.14	92.98	0.000	0.76
	Reading ability	26665.85	1.55	17254.94	147.46	0.000	0.84
	Sound change	21.43	1.96	10.89	41.31	0.01	0.59
	Reading comprehension	225.16	1.55	145.34	151.04	0.000	0.84
Group × Assessment time (interaction)	Phonological fluency	544.01	2	272	36.38	0.01	0.49
	Semantic fluency	232.51	1.2	193.8	30.19	0.01	0.44
	Comprehension	9917.26	1.10	8981.55	63.90	0.01	0.63
	Direct digits	2.11	1.91	1.1	7.13	0.01	0.16
	Inverse digits	8.51	1.84	4.60	20.31	0.01	0.34
	Attention registration 1	2880.15	1.28	2240.94	36.09	0.01	0.49
	Attention registration 2	175.71	1.39	125.68	4.17	0.03	0.09
	Attention registration time	2407.85	1.25	1923.94	0.12	0.78	0.01
	Naming	31314.95	1.48	21159.48	176.51	0.01	0.82
	Naming time	53.51	1.25	42.57	0.02	0.91	0.01
	Alphabet reading 1	922.16	1.00	922.16	57.00	0.000	0.66
	Alphabet reading 2	4607.82	1.00	4607.82	85.98	0.000	0.75
	Word reading	248.24	1.59	156.44	130.87	0.000	0.82
	Reading ability	32086.63	1.55	20762.61	177.44	0.000	0.86
	Sound change	21.43	1.96	10.89	41.31	0.01	0.58
	Reading comprehension	282.88	1.55	182.60	189.76	0.000	0.87

difference between the scores of participants in at least two stages of the triple trials if we ignore the subjects' group (intervention and control). Also, the main effect of the interaction of the subjects with the testing stages, other than the time of attention and the time of naming in the remaining variables was significant, indicating that the two groups of intervention and control were different in at least two stages of the triple trials (Table 4).

Within-group effects test showed that there was a difference between the testing stages. The LSD post hoc test was examined for a closer examination of the difference in stages. The results showed that there was a significant difference between comprehension in all stages of the test, and the performance of the participants in the follow up was better than the post-test and in the follow-up and post-test better than the pre-test. In attention the verbal fluency, semantic fluency, verbal memory of inverse digits, register 1 and 2, naming, reading alphabet 1 and 2, reading vocabulary, reading ability, Sound change and comprehension of questions,

Table 4: LSD post hoc test for difference of assessment time

Variable	Assessment time		Mean Difference	Std. Error	Sig.	95% Confidence Interval for Difference	
						Lower Bound	Upper Bound
Phonological fluency	Pre-test	Post-test	-0.347	0.72	0.01	-4.94	-2
		Follow-up	-3.4	0.74	0.01	-4.9	-1.89
	Post-test	Follow-up	0.07	0.2	0.71	-0.33	0.48
Semantic fluency	Pre-test	Post-test	-2.82	0.56	0.01	-3.96	-1.68
		Follow-up	-2.62	0.46	0.01	-3.56	-1.68
	Post-test	Follow-up	0.2	0.21	0.36	-0.24	0.64
Comprehension	Pre-test	Post-test	-16.20	3.71	0.01	-23.70	-8.70
		Follow-up	-18.10	4.02	0.01	-26.23	-9.97
	Post-test	Follow-up	-1.90	0.69	0.01	-3.30	-0.50
Direct digits	Pre-test	Post-test	-0.170	0.9	0.07	-0.36	0.01
		Follow-up	-0.07	0.08	0.35	-0.23	0.08
	Post-test	Follow-up	0.10	0.08	0.24	-0.07	0.27
Inverse digits	Pre-test	Post-test	-0.52	0.11	0.01	-0.75	-0.29
		Follow-up	-0.42	0.10	0.01	-0.62	0.22
	Post-test	Follow-up	0.10	0.09	0.28	-0.08	0.28
Attention registration 1	Pre-test	Post-test	9.73	2.26	0.01	5.15	14.30
		Follow-up	10.85	2.38	0.01	6.03	15.67
	Post-test	Follow-up	1.13	0.75	0.14	-0.39	2.64
Attention registration 2	Pre-test	Post-test	3.22	1.02	0.03	1.15	5.29
		Follow-up	3.65	1.28	0.01	1.04	6.25
	Post-test	Follow-up	0.42	0.67	0.53	-0.94	1.79
Attention registration time	Pre-test	Post-test	20.47	26.35	0.386	-26.79	67.74
		Follow-up	31.52	27.80	0.364	-24.75	87.80
	Post-test	Follow-up	11.05	11.55	0.345	-12.34	34.44
Naming	Pre-test	Post-test	-33.48	6.07	0.01	-45.74	-21.21
		Follow-up	-34.75	5.88	0.01	-46.64	-22.86
	Post-test	Follow-up	-1.28	1.36	0.35	-4.04	1.49
Naming time	Pre-test	Post-test	-4.55	5.93	0.48	-16.5	7.47
		Follow-up	-4.62	9.36	0.62	-14.32	23.57
	Post-test	Follow-up	9.17	5.13	0.08	-1.21	19.56
Alphabet reading 1	Pre-test	Post-test	-6.82	0.89	0.01	-8.63	-5.01
		Follow-up	-6.82	0.89	0.01	-8.63	-5.01
	Post-test	Follow-up	0.01	0.01	.	0.01	0.01
Alphabet reading 2	Pre-test	Post-test	-14.87	1.61	0.01	-18.17	-11.58
		Follow-up	-14.87	1.61	0.01	-18.17	-11.58
	Post-test	Follow-up	0.01	0.01	.	0.01	0.01
Word reading	Pre-test	Post-test	-2.96	0.25	.01	-3.47	-2.46
		Follow-up	-2.88	0.30	0.01	-3.49	-2.27
	Post-test	Follow-up	0.09	0.19	0.64	-0.29	0.46
Reading ability	Pre-test	Post-test	-37.07	2.51	0.01	-42.21	-31.93
		Follow-up	-34.69	2.88	0.01	-40.59	-28.80
	Post-test	Follow-up	2.38	1.70	0.17	-1.10	5.85
Sound change	Pre-test	Post-test	-1.06	0.12	0.01	-1.31	-0.8
		Follow-up	-0.97	0.13	0.01	-1.25	-0.69
	Post-test	Follow-up	0.09	0.12	0.46	-0.16	0.35
Reading comprehension	Pre-test	Post-test	-3.25	0.21	0.01	-3.67	-2.82
		Follow-up	-3.36	0.27	0.01	-3.91	-2.81
	Post-test	Follow-up	-0.11	0.17	0.51	-0.45	0.23

the difference between the pre-test with the post-test was significant, but the difference between post-test and follow-up was non-significant.

Discussion

According to the results, the phonological fluency and also the semantic fluency subscales of the verbal fluency significantly improved in the intervention group. The post-test scores were better than pre-test scores and also follow-up scores were better than pre-test scores. As previously mentioned, rehabilitation focused on enhancing the various dimensions of attention and working memory seems that transferred to the verbal fluency speed. The predictor role of the working memory in verbal fluency was confirmed in several studies [34, 35]. The transfer of the effect of working memory to verbal fluency was also shown in a study by Hinsel et al. [36]. Evidence of the involvement of executive functions in verbal fluency function was first derived from studies that showed that ADHD children had lower scores compared to TD children in verbal fluency [4, 37]; afterwards, studies revealed that damage to the frontal regions of brain was associated with poor performance in verbal fluency tasks [38, 39]. The increase in verbal fluency in both phonological and semantic, resulting from the enhancement of attention and working memory is an important confirmation of the causal role of these two cognitive functions in the process of naming performance. Paying attention to the instructions and keeping them in mind during the task and retrieving information from long-term memory, inhibiting internal and external stimuli, and maintaining attention were necessary for doing the naming tasks.

Findings about the variable of the receptive language showed that the intervention group in the post-test performed better than the pre-test, and their performance in follow-up was better than the post-test. Therefore, regarding the variable of the language comprehension, an increase in the effect of the intervention even after the intervention period was observed. Attention and working memory as main cognitive resources were needed for understanding and comprehension; and their enhancement could increase the available resources and improve the receptive language.

In general, a research background indicates the relation between working memory and reading comprehension. Part of the correlation between working memory capacity and reading comprehension can be explained by attention control on distracting thoughts [40] and indicate the role of attention in the process of comprehension. Working memory is required to keep verbal information while reading. Several studies have shown that there was a relationship between working memory and reading comprehension [41, 42]. Positive, weak-to-moderate correlation between working memory capacity and reading comprehension was also revealed in a meta-analysis [43]. According to the research, poor reading skills were correlated with poor attention and working memory performance [44]. A study by Dahil on Swedish children showed that working memory correlated with word reading performance and reading comprehension, and by improving working memory, it also improved word reading and reading comprehension [45].

Our findings showed that the scores of the intervention group in the naming test had a significant difference in the post-test, but there was no significant change in the post-test to the follow-up. There was no change in the naming time at any of the testing steps. While Deker et al. found that attention and short-term memory could not predict rapid naming performance [46], other research revealed that there was a positive correlation between attention and naming capabilities [47-49]. It seems that enhancing attention and working memory could increase the available resources needed for recalling the word and names from long-term memory and boost the speed of naming.

Findings showed that the verbal memory of direct digits in post-test or follow-up had no significant improvement compared to the pre-test. But the verbal memory of inverse digits had a significant improvement in the post-test and follow-up stages compared to the pre-test. So we could conclude that whereas, cognitive rehabilitation of working memory and attention did not enhance the phonological capacity, but they boosted the performance of central executive.

Also, the results showed that Attention registration 1 (omissions) and Attention registration 2 (commissions) improved significantly in post-test and follow-up in comparison with the pre-test. Transfer of the attention and working memory effects were also observed in this case and they revealed that attention was a domain-general ability and enhancement of one aspect of it could transfer to the others.

Conclusion

In general, one must keep the instruction in his working memory (Shao et al., 2014) and, of course, she/he must have paid enough attention to the instructions beforehand to enable him/her carry out verbal tasks. Also, one must ignore unrelated responses and unrelated internal and environmental stimuli. On the other hand, the larger the working memory, the more the resource of the required cognitive function was needed for linguistic skills and the language expression will be improved [42].

Our research hypothesis which was mentioned in the introduction was that; cognitive rehabilitation improves the verbal abilities and skills of children with ADHD. In general, the results of the research, confirmed this hypothesis in all aspects of the verbal skills assessed in this study, but with some limitations (regarding the time of naming and the time of attention register).

Acknowledgment

This research was conducted as a part of a Ph.D. thesis in Shahid Beheshti University and the authors gratefully acknowledge the children and their families who participated in this study. This study was reviewed and ethical approval was received through the Psychology Department of Shahid Beheshti University.

Conflict of interest: None declared.

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