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Research Paper

Cognitive Rehabilitation Training in Improving Executive Function, Antisocial Behaviors, and Legal Problems in Children With Attention-Deficit/Hyperactivity Disorder

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ABSTRACT

Background: Attention Deficit Disorder/Attention-Deficit/Hyperactivity Disorder (ADD/ADHD) is one of the most prevalent childhood diseases, and it may substantially influence social behaviors, legal issues, and disputes. The goal was to see how cognitive rehabilitation training affected executive functioning and impulsivity in children with ADHD in Tehran, District 5.

Methods: A quasi-experimental design was used, with two groups (experimental and control) and a pretest-posttest. All students with ADHD disorder aged 7 to 12 years were included in the statistical population. The sample comprised 30 kids who were age-matched and randomly split into two groups. They were tested for two months in February and March 2021. Slow cognitive rehabilitation training was given to the experimental group. Both groups were given a pretest and a posttest. Information was gathered using the BRIEF (parent form) and Conners' (parent form) questionnaires. MANCOVA was used to analyze the data, using the SPSS software v. 26, with a significance threshold of 0.05.

Results: There was a significant difference in executive function variables (inhibition, attention transfer, emotional control, initiation, working memory, planning, material organization, and control) and reduced impulsivity (attention deficit , hyperactivity, opposition, and ADHD) ($P \leq 0.001$).

Conclusion: Cognitive rehabilitation improves executive skills and impulsivity in children with ADHD aged 7-12 years. Cognitive rehabilitation training should be utilized with other educational approaches to rectify social behaviors, minimize conflict, and improve executive functions.

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1. Introduction

Attention Deficit Disorder/Attention-Deficit/Hyperactivity Disorder (ADD/ADHD) is a developmental neurological disorder that begins in childhood. Attention deficit, hyperactivity, and impulsivity are the essential characteristics of this condition [1]. Environmental, genetic, and physiological variables combine to produce clinical symptoms [2]. Numerous studies have shown a strong link between ADHD and anxiety, depression, addiction, and antisocial and criminal conduct [3, 4]. According to reports, these individuals have an 8-fold higher rate of legal issues than the general population, indicating a critical need to identify and treat them [5]. Failure to detect and treat this condition in infancy, on the other hand, may lead to conduct problems, antisocial personality, and significant legal issues [6].

Behavioral inhibition and executive dysfunction are two of the most significant issues in children with ADHD [7]. Executive functions are a group of superior cognitive and metacognitive skills that conduct inhibition, self-initiation, strategic planning, adaptability, and impulse control.

Functions such as organizing, decision making, working memory, motor control, time perception, forethought, reconstruction, and problem-solving can be considered the most critical neurological functions that help human beings in life and learning tasks, intelligence actions, and decision making [8].

Although medication therapy is the primary treatment for this condition, cognitive rehabilitation treatment has recently been suggested as one of the therapeutic options for improving the executive functioning of children with ADHD. Rehabilitation therapy improves a child's attention, memory, inhibition, organization, planning, and decision-making skills and executive functions in attention, memory, inhibition, organization, planning, and decision-making. Several types of research have shown their effects on children with ADHD [9].

Rahmani et al. [10] discovered that computer-assisted cognitive rehabilitation training enhances the executive and impulsive skills of children with ADHD. Rehabilitation training, in other studies, has also been demonstrated to increase executive skills such as working memory, attention span, cognitive flexibility, and impulsivity [11], processing speed and working memory capacity, impulsivity, and executive function [12], working memory speed [13], attention, concentration, control, memory, and impulsivity [14], response inhibition variables, continuous attention, focused attention, and selective attention [15], impulsivity, working memory [16], attention and behavioral problems [17], working memory and impulsive behavior reduction [18], and memory, attention, control, and inhibition functions [19].

The creation of cognitive rehabilitation programs and their impact on improving executive and impulsive functions, besides medication therapy approaches, seem to be successful in treating children with ADHD. It should be mentioned that cognitive rehabilitation training needs further research and reflection, focusing on discovering the components that enhance executive function and minimize impulsive conduct in these kids. Given the lack of studies in the country focusing on the effects of cognitive rehabilitation training on executive functions and impulsive behaviors of ADHD children, this study was conducted to see how effective cognitive rehabilitation training is at improving executive functions and impulsivity in these children.

2. Material and Method

The study was quasi-experimental, with a pretest/posttest design and two experimental and control groups. The statistical population of this study consisted of 7 to 14-year-old students with ADHD in primary school. After multi-stage cluster sampling, first selected from among the 20 educational districts of Tehran, District 5, and then from among primary schools, 6 schools were randomly selected. The sample size was calculated using comparative research involving 30 adolescents. They were chosen by introducing their teachers based on the criteria in the DSM-5 and through the implementation of the BRIEF (parent form) and Canners (parent form) questionnaires. They were randomly allocated to the experimental and control groups (15/15).

To match and control age and gender, the method of matching samples (by selecting pairs or groups of individuals with almost the same characteristics) and determining one group of them as a case group and the other as a control and also through random assignment and Selection of subjects so that the chance of Selection for each subject is equal, we were able to control the variables of gender and age to the desired level.

After obtaining the informed consent of parents, case groups participated in the "ARAM Cognitive Rehabilitation Program." Exclusion criteria included the coexistence of any mental, physical, cerebral, or specific sensory-motor disabilities in children. Informed consent

was obtained from the parents, and ethical considerations were provided. The information is confidential, and the researchers must observe the Helsinki Convention (Code: IR.IAU.SRB.REC.1399.002).

At first, parents completed the "Connor's Executive Functions and Behavior Assessment Questionnaire" to access their children's behaviors and practices at home. The technique was to explain the research's aims and values to parents. Subsequently, the parents submitted the informed consent, and it was made clear to them that if they did not want to, they might quit at any time without having to worry about continuing with their regular schooling. The researcher then led ARAM Cognitive Rehabilitation Program.

The training included cognitive assignments 3 times a week during 12 sessions of 20 minutes. ARAM Cognitive Rehabilitation Program is a set of Computer-based Cognitive Rehabilitation program tools designed to enhance various aspects of attention. The design of this package is based on Solrigg and Meter attention model and the Bedly working memory model (Table 1).

The program consists of two parts: evaluation and intervention. Assignments in both sections are hierarchically graded from easy to difficult. Evaluation includes validated neurological tests adapted to the "ARAM program." Tests Designed to Assess Include the "Stroop Test," "Continuous Performance Test," "Wisconsin Card Sorting Test," "Previous One Stimulus Test" (for measuring low-load working memory), and "Two Previous Stimuli Test" (for measuring high-load active memory) as pretest-posttest.

Intervention tasks include Color Box Assignments, Face Assignments, Similar Window Assignments, Markup Table Assignments, Cross-sectional Assignments, "Final Color Assignments, Animal Tracking Assignments, Duplicate Assignments, and Word Matches and Delayed Pairing Assignments.

Color Box Assignments have ten difficulty levels based on the number of stimuli, presentation speed, complexity, and program rules. The decision to perform the higher game stages is based on the child's performance. If the child fails to answer a step up to 80% correctly, that step will be repeated. Homework increases the ability to change attention, sustain attention, deter, and ultimately strengthen working memory. The homework of this educational package is very refreshing and is presented with attractive stimuli to enhance the child's motivation to do them.

Instruments

The Behavior Rating Inventory of Executive Function (BRIEF) (parents form)

BRIEF is an assessment of executive function behaviors at home and at school for children and adolescents ages 5–18. Each BRIEF parent- and teacher- rating form contains 86 items in eight non-overlapping clinical scales and two validity scales. These theoretically and statistically derived scales form two indexes: A) Behavioral Regulation (Inhibit, Shift, Emotional Control) and B) Metacognition (Initiate, Working memory, Plan/Organize, Organization of Materials, Monitor), as well as a Global Executive Composite score which takes into account all of the clinical scales and represents the child's overall executive function. There are also two validity scales to measure Negativity and Inconsistency of responses. Scores on the Negativity scale measure the extent to which the respondent answered selected items unusually negatively. In contrast, scores on the Inconsistency scale indicate the degree to which the respondent inconsistently replied similar items.

Questions selected for inclusion in the BRIEF were determined based on inter-rater reliability correlations and item-total correlations that had the highest probability of being informative for the clinician. The BRIEF has demonstrated good reliability, with high test-retest reliability (rs≈0.88 for teachers, 0.82 for parents), internal consistency (Cronbach's alphas≈0.80–0.98), and moderate correlations between parent and teacher ratings (rs≈0.32–0.34). Evidence for the convergent and divergent aspects of the BRIEF's validity comes through its correlation with other measures of emotional and behavioral functioning.

Shahabi [21] conducted a study and measured the validity and reliability of the questionnaire that the reliability coefficient concerning the test-retest of the subscales of the test of behavioral ranking of executive functions in the inhibition function was achieved 0.90, orientation 0.81, emotional control 0.91, start to work 0.80, working memory was 0.71, planning was achieved 0.81, organizing the component was 0.79, monitoring was performed 0.78, behavior regulation index was 0.90, metacognition index was 0.87, and the total score of executive functions was achieved 0.89. The internal consistency coefficient for this questionnaire is from 0.87 to 0.94 and indicates the high internal consistency of all subscales of the questionnaire [22].

Table 1. Treatment based on relaxed cognitive rehabilitation

Task Types	Cognitive Function of the Target	Descriptions
Regular homework faces	Change of attention	In this task, the subject must arrange the image of the faces based on their emotional manifestations (happy, sad, and neutral), hair color (green, black, and white), and face color (black, white, and yellow) in different classes according to the rules.
Homework closed classification	Inhibition	This task includes a goal stimulus that is constantly changing. The subject should find the same among the stimuli at the bottom of the page. It is important to consider the type of target stimulus when selecting.
Similar window assignment	Working memory	In this task, pictures in the table cells were covered, and the subject must find similar images in the table.
Last colors assignment	Sustained attention	The subject must find the target image, each component of which has a different color, from several rows of the image that are similar in shape but different in color.

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Conners' Parent Rating Scale (CPRS)

One of the traditional instruments to measure children's behavior is based on a dimensional classification system and includes children's several behavioral questionnaires. This scale was first produced to assess stimulant medicines' influence on children who have ADHD and to recognize these children from normal children. It is normal to use a modified form of a questionnaire (27 items) to diagnose children with ADHD. The reliability coefficient of the retest for the total score is 0.58, and the Cronbach's alpha coefficient for the total score is 0.73. Its validity is 0.84, which measures the three factors of coping behavior, hyperactivity and attention deficit. The range of scores for each question is different from zero to 3 that scales include not accurate at all (never), 2) simply somewhat true (occasionally), 3) approximately true (often), 4) entirely true (extremely high) [23].

Descriptive statistics (frequency, percentage, mean and standard deviation) were applied to describe the data utilizing SPSS software v. 26, and the MANCOVA test was used to analyze the data.

3. Results

The samples were in the age range of 7-11 years (case (Mean±SD: 8.66±1.17 years) and control (Mean±SD:

Table 2. Frequency and percentage of age and educational level

Groups	Age	Grade	Frequency	Percentile
Case	7	First	3	20
	8	Second	3	20
	9	Third	6	40
	10	Fourth	2	13.3
	11	Fifth	1	6.7
	Total	Total	15	100
Control	7	First	4	26.6
	8	Second	5	33.3
	9	Third	3	20
	10	Forth	1	6.7
	11	Fifth	2	13.3
	Total	Total	15	100

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Table 3. Executive and impulsivity function scores in with and without intervention groups

Groups	Variables	Dimensions	Groups	No.	Mean±SD	
					Before test	After test
Cognitive Rehabilitation	Executive Functions	Inhibition	Case	15	18.06±4.51	13.80±3.80)
			Control	15	15.13±4.94	17.53±4.67)
		Attention transfer	Case	15	12.60±2.5	9.13±4.01)
			Control	15	8.93±2.47	13.00±3.48
		Emotional control	Case	15	14.20±2.65	11.06±2.52
			Control	15	15.20±2.95	15.73±3.19
		Initiation	Case	15	11.86±2.66	8.26±1.94
			Control	15	8.26±2.21	10.93±2.71
		Working memory	Case	15	12.46±2.09	9.26±2.18
			Control	15	10.40±2.87	13.26±2.76
		planning	Case	15	23.66±4.54	19.93±4.87
			Control	15	20.80±4.91	24.80±4.72
		Organize materials	Case	15	10.86±3.52	8.20±3.004
			Control	15	10.40±3.37	12.73±2.34
		Control	Case	15	9.00±3.50	12.20±3.23
			Control	15	11.46±3.88	11.03±2.91
	Impulsivity	Cognitive-inattention problems	Case	15	13.33±2.09	10.33±2.60
			Control	15	13.06±2.52	14.60±1.76
		Hyperactivity	Case	15	20.80±2.45	17.13±2.41
			Control	15	18.20±4.39	21.13±2.47
		Opposition	Case	15	18.26±3.39	14.73±2.52
			Control	15	14.06±2.12	17.26±3.03
		ADHD	Case	15	30.46±4.76	27.13±3.87
			Control	15	28.33±7.37	31.66±6.01

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8.26±1.33 years), and in terms of gender, 56.6% were boys (53.3% case and 60% control, respectively) (Table 2)

Table 3 compares the two groups' mean scores on executive function dimensions and the Connors grading scale. There was no significant difference between the two groups. However, in the posttest, there was a significant difference between the two groups in all dimensions of executive functions (inhibition, attention transfer, emotional control, initiation, working memory, planning, organizing materials, and management) and impulsivity (Cognitive Function, Hyperactivity, Opposition, and ADHD) (P≤0.001).

As shown in Table 4, there is a significant difference between hyperactive students in the case and control

Table 4. MANCOVA on the mean scores of posttest of executive functions and impulsivity of Case and Control groups with pretest control

Test Power	Title of Exam	Amount	Degrees of Freedom	Error	F	Effect Size	Test Power	Sig.
Executive functions	Pillay effect test	0.97	16	13	45.67	0.97	1	0.001
	Lambda Wilkes test	0.02	16	13	45.67	0.97	1	0.001
	Test Effect Hoteling	45.67	16	13	45.67	0.97	1	0.001
	Test the largest Root on	45.67	16	13	45.67	0.97	1	0.001
Impulsivity	Pillay effect test	0.92	8	21	30.74	0.92	1	0.001
	Lambda Wilkes test	0.07	8	21	30.74	0.92	1	0.001
	Test Effect Hoteling	11.71	8	21	30.74	0.92	1	0.001
	Test the largest Root on	118.71	8	21	30.74	0.92	1	0.001

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groups, at least in terms of one of the dependent variables of the dimensions of executive function (inhibition, attention transfer, emotional control, initiation, working memory, planning, organizing materials, and control) (P≤0.001, F=37.10) and Connors rating scale (cognitive-inattention problems, hyperactivity, opposition, and ADHD) (P≤0.001, F=30.74). One-way ANCOVA was performed to find out which variable was different. The effect or difference is equal to 0.97 and 0.92. In other words, 0.97% of individual differences in posttest scores of executive performance dimensions and 0.92% on the Connors Grading Scale are related to the effect of cognitive rehabilitation training. According to the statistical power equal to 1, there was no error in the second type.

As indicated in Table 5, controlling the pretest between the two groups shows a significant difference in executive functions and impulsivity. In other words, 0.13, 0.27, 0.45, 0.17, 0.46, 0.30, 0.44, and 0.41% of individual differences in improving the dimensions of execu-

Table 5. One-way MANCOVA on the mean scores of executive functions and impulsivity of case and control groups

Variables	Dimensions	Total Squares	Degrees of Freedom	Average Squares	F	Sig.	Effect Size	Test Power
Executive Functions	Inhibition	80.03	1	80.03	4.49	0.04	0.13	0.53
	Attention transfer	172.80		172.80	10.50	0.003	0.27	0.87
	Emotional control	218.70		218.70	22.99	0.000	0.45	0.99
	Start	38.53		38.53	5.83	0.02	0.17	0.64
	Working memory	149.63		149.63	24.74	0.000	0.46	0.99
	planning	197.63		197.63	12.41	0.001	0.30	0.92
	Organize materials	168.03		168.03	22.73	0.000	0.44	0.99
	Control	97.20		97.20	19.79	0.000	0.41	0.99
Impulsivity	Cognitive-inattention problems	208.03	1	208.03	45.17	0.000	0.61	1
	Hyperactivity	258.13		258.13	28.38	0.000	0.50	0.99
	Opposition	83.33		83.33	6.98	0.01	0.20	0.72
	ADHD	282.13		282.13	8.90	0.006	0.24	0.82

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tive functions (reduction of inhibition, attention transfer, emotional control, initiation, working memory, planning, organizing materials, and control, respectively) and 0.61, 0.50, 0.20 and 0.24% in impulsivity dimensions (cognitive-inattention problems, hyperactivity, opposition, and ADHD, respectively) is related to the effect of cognitive rehabilitation training.

4. Discussion

This research aimed to see how cognitive rehabilitation therapy affected hyperactive children's executive functioning and impulsivity groups. The results of the posttest phase revealed that there is a significant difference between the experimental and control groups in executive functions (inhibition, attention transfer, emotional control, initiation, working memory, planning, material organization, and control) and impulsivity (cognitive-inattention problems, hyperactivity, opposition, and ADHD ($P \leq 0.001$). These findings are in line with those of earlier studies in this sector [10-19].

Rahmani et al. [10] discovered that computer-based cognitive rehabilitation improves executive function. Aivazy et al. [11] found that cognitive rehabilitation training enhanced executive functions of response inhibition in children with ADHD. Faizipour et al. [12] and Nazarboland et al. [13] demonstrated that cognitive rehabilitation training improved executive functions such as selective attention, inhibitory control, and working memory, as well as lowering impulsive behaviors in independent trials. Ranjbar et al. [14] found that cognitive rehabilitation improves executive skills, including attention, focus, control, memory, and impulsive behaviors like hyperactivity and frustration. In another research, Robertmili et al. [18] discovered that computer rehabilitation enhances children's working memory and lowers impulsive behaviors. Cognitive rehabilitation improves memory function, attention, control, and inhibition, according to Kisneros et al. [19].

According to these results, cognitive rehabilitation treatments focus on cognitive retraining processes via practice, adaption, and implicit and explicit learning of coping strategies. This approach is based on an information processing system that offers feedback on individual skills and self-efficacy; as a result, a suitable training program can be designed depending on the person's talents. Computer programs for cognitive training give tools to assist people in enhancing their mental-base processes in high-level learning. Computer cognitive rehabilitation programs may help children with ADHD improve cognitive processes and minimize impulsive behaviors.

During cognitive rehabilitation, cognitive training based on brain flexibility is used to address these children's cognitive deficiencies directly. Activities to develop executive actions, including attention, focus, and memory skills, as well as exercises to strengthen linguistic and time-chain manipulation skills, have resulted in better executive actions in children with dyslexia. As a consequence, cognitive rehabilitation works to improve executive functions through enhancing mental and cognitive capacities. Working memory, reaction inhibition, planning, and mental organization are all improved with cognitive rehabilitation training, as are decoding, psychic reading, and understanding. Given the importance of executive actions and their crucial role in developing executive functions and reducing impulsive behaviors, it is reasonable to expect that effective organizational action interventions will impact the outcome of executive functions and the removal of impulsive behaviors.

As a result, experts and academics recommend that educational packages centered on enhancing executive functions and lowering impulsive behaviors be developed to help ADHD children and their families improve their Quality of Life (QoL).

Ethical Considerations

Compliance with ethical guidelines

The Ethics Committee of the Islamic Azad University approved this study (Code: IR.IAU.SRB.REC.1399.002)

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Authors' contributions

All authors equally contributed to preparing this article.

Conflict of interest

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