



# The Effectiveness of Cognitive Rehabilitation Therapy on Cognitive Functions (Working Memory, Concentration, and Attention) of Adolescents Living in Boarding Schools

Behnoush Hamedali<sup>1</sup>, Javad Khalatbari<sup>2\*</sup>, Saeid Malihi Alzakerini<sup>3</sup>, Mohammadreza Seyrafi<sup>3</sup>

<sup>1</sup> PhD Student, Department of Psychology, UAE Branch, Islamic Azad University, Dubai, United Arab Emirates

<sup>2</sup> Associate Professor, Department of Psychology, Tonekabon Branch, Islamic Azad University, Tonekabon, Iran

<sup>3</sup> Assistant Professor, Department of Psychology, Karaj Branch, Islamic Azad University, Karaj, Iran

## \*Corresponding author:

Javad Khalatbari, Department of Psychology, Tonekabon Branch, Islamic Azad University, Tonekabon, Iran  
Tel: ?  
Email: J.khalatbari@toniau.ac.ir

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## Abstract

**Background and Objective:** Cognitive rehabilitation is a way to restore lost cognitive capacities. This study aimed to investigate the effectiveness of cognitive rehabilitation therapy on cognitive functions (working memory, concentration, and attention) of adolescents living in boarding schools in Tehran.

**Materials and Methods:** This study was a quasi-experimental research with pre-test and post-test design. The statistical population includes all adolescents living in welfare boarding schools in the age group was 15 to 18 years old, and they were in Tehran in 2018. Out of 100 people, 60 people who had problems in the mentioned variables were randomly selected, and randomly divided into two groups of 30 people. The first group underwent eight individual sessions of cognitive rehabilitation therapy (by NBK software), and the second group, as a control group, did not receive any treatment. Data were analyzed by multivariate analysis of covariance and Spss.22 software.

**Results:** The results showed that the effectiveness of cognitive rehabilitation therapy was effective on cognitive functions (working memory, concentration, and attention) of adolescents ( $P < 0.001$ ).

**Conclusions:** It can be concluded that cognitive rehabilitation can successfully affect numerous aspects of cognitive functions, while numerous medical therapies may be required to treat each mere aspect. Further evaluations are strongly recommended.

**Keywords:** Adolescent, Attention, Cognition, Memory, Schools

## Background

Cognitive functions of the brain cover a wide range of cognitive capacity and processes, including verbal reasoning, problem-solving, planning, ordering, the ability to retain attention, benefit from feedback, multitasking, cognitive flexibility, and the ability to manage new situations. Another part of these functions is the cognitive executive functions that exist in the child from birth, and this force also grows with the growth of the child, and at the age of 12, the executive functions of the child have the same functions as adults [1].

Cognitive rehabilitation is a way to restore lost cognitive capacities. Which is done by exercises and providing purposeful stimuli, and its purpose is to improve the performance of the person in performing activities. In this method, the therapist considers the information obtained from the evaluation of the sessions and, based on it, designs tasks to strengthen the cognitive functions of the brain and increases the difficulty of the task as the patient progresses. Cognitive rehabilitation can be used for children, adolescents, adults, and the elderly [2]. Cognitive rehabilitation includes providing

performance-oriented therapeutic activities aimed at strengthening or re-establishing previous behavioral patterns and establishing new behavioral patterns for performing activities or providing cognitive mechanisms to compensate for damaged nervous system functions [3].

In cognitive rehabilitation, we face two main approaches, the compensation or compromise approach, and the other cognitive therapy approach. In practice, the separation of the two approaches never occurs, and the overlap of the two in treatment is inevitable. The first approach is the compensation or adaptation approach. In this approach, the goal is to remove the limitations of the individual by making changes in the environment, habits, and methods of doing things as well as executive strategies [4]. These three therapeutic goals are reminiscent of cognitive ergonomics, which is based on the principles of information processing and reduces working memory involvement. In cognitive empowerment programs, executive functions are used to increase empowerment in the individual [5].

Children and adolescents living in boarding schools perform significantly lower in developmental areas, especially behavioral and intelligence tests and speech abilities than normal children [6]. Delays in cognitive development and social adjustment lead to academic problems during the school years [7]. Even if these children and adolescents are adopted after living in welfare centers for some time, they will suffer from problems such as delayed development of social skills and avoidance behaviors [8]. The result of some studies like Shahabpouri et al [9] showed that cognitive rehabilitation could significantly improve MS patients' cognitive performance. Rezapour et al [10] showed that the cognitive rehabilitation treatment group performed significantly better in tests of learning, switching, processing speed, working memory and memory span. Moreover, the cognitive rehabilitation treatment group had significantly lower opiate use over the control group during 3-months follow-up. The result of Molt et al., [11] showed that cognitive rehabilitation was effective on walking, cognition, and cognitive–motor interactions in MS patients. Furthermore, results of Lee et al., [12] showed that computer-assisted cognitive rehabilitation training was an effective intervention method for the improvement of the cognition and balance abilities of the elderly. Baltaduoniene et al., [13] showed that computer-based cognitive rehabilitation programmes may help to improve cognitive functions in subjects after stroke.

Therefore, since living in welfare center environments can have a huge impact on the mental and personality states of children and adolescents and predispose them to be psychiatric and emotional disorders, so identify and evaluate cognitive executive functions and improve anxiety and depression and Communication skills in children and adolescents of these centers can provide a way to provide a suitable environment for cognitive and metacognitive rehabilitation and solve future educational and professional problems of this group.

### Objectives

The purpose of this study was to investigate the effectiveness of cognitive rehabilitation therapy on cognitive functions (working memory, concentration, and attention) of adolescents living in boarding welfare centers in Tehran.

### Materials and Methods

The research method in the present study is a quasi-experimental three-group with a pre-test-post-test with follow-up. The statistical population includes all adolescent girls and boys living in boarding

schools in 15 to 18 years in Tehran in 2018. The statistical sample is selected by convenience sampling method and simple random sampling method. The sample size is 100 adolescents living in welfare boarding centers selected as available in the first stage. All of them were pre-tested, and 60 of them who have attention deficit and concentration or Memory impairment were selected. This group of 60 people was randomly divided into two groups, and the first group was randomly assigned to at least eight sessions of cognitive rehabilitation therapy with N-Back software. The second group was control group which did not receive any treatment. At the end of these 60 subjects, a post-test was taken, and pre-test and post-test were compared.

To obtain from the range of natural intelligence of the subjects, all participants in the Wechsler intelligence test were also included, each of whom had a normal IQ range between 90 and 140. Also, in the end, after six months, follow-up tests were performed again and analyzed along with the previous tests. Inclusion criteria were conscious consent for presenting in the study, the ability to attend group therapy sessions, no history of chronic physical illness, age 15 to 18 years, and non-participation in psychological training classes at the same time. Exclusion criteria included the absence of more than two sessions of therapy.

### Intervention

The cognitive rehabilitation schedule consisted of rehabilitation entities, including attention, concentration, visual and auditory memory, and autobiography memory. The approaches were performed considering the severity of cognitive impairment and with the aim of optimization of the residual functions. To achieve the mentioned rehabilitative programs, the mnemonic approach was utilized, which includes visual imagery, theological organization, and relational strategies including mnemonics of fiction, the clues about the first word, chain connection, and the technique of PQIRST (Preview, Question, Read, Self-recitation, and Test). The sessions were performed as follows: Cognitive rehabilitation therapy was performed with N-Back software. After taking the pre-test, each subject individually had about eight training sessions, each session lasting about twenty minutes to half an hour. At the end of these sessions, post-test tests were taken from the subjects. Was, was compared and after six months after the post-test, again from the subjects, the follow-up test was performed, and the results were compared with the post-test results. The technique of recalling positive memories through autobiographical memory was

trained, and then, the psychologist presented several samples and requested the participants to recall and then present their positive memories.

NBack software is a computer program that helps people with impaired cognitive memory, working memory, and attention to regain their cognitive ability. N-Beck can also help adolescents with cognitive impairments, such as attention or concentration disorders, or memory impairment, and can also indirectly reduce anxiety and worry by improving memory and attention, such as test anxiety, which improves memory and attention to anxiety disorder can help to eliminate this disorder or even improve their level of cognitive abilities.

This test measures cognitive function related to executive actions that are commonly used in neuroimaging studies to stimulate brain function in subjects. Memory plays a key role in almost all learning. Memory refers to the ability to store information learned through the senses and perception; It also refers to the ability to read that information when needed. N-Back 2 is an exercise to enhance working memory that was first used in a 2008 study. The different parts of the N-back show that you have to remember a few steps before deciding and answering about the same place or sound. While performing this task, executive actions such as controlling and allocating attention, making decisions, planning environmental information processing, etc. are involved. In working memory, when doing this task, the most conflict occurs in the performance of the central processing system. Cognitive rehabilitation in this study is performed with NBK software, which is performed during eight sessions of individual therapy. N-back is a software system that helps rehabilitate people with cognitive impairments. This software helps treat cognitive rehabilitation disorders that affect aspects of attention, memory, comprehension, and daily activities of life, as well as indirectly improving anxiety and worry.

The Computer IVA test is used to assess attention and impulsivity, and its focus is more on people with attention deficit and impulsivity disorders and those with attention deficit. This test is performed for people six years and older. This test is a computer test that first has a tutorial that teaches the steps and how to test, and after the initial training, the test begins and lasts about 20 minutes.

This test is both visual and auditory. The results of studies show that the IVA test is designed to detect attention deficit, inattention, and impulsivity, so this test has sufficient sensitivity (92%) and predictive power (89%) to diagnose ADHD in children [14] correctly. The validity of the test in the open test method shows that the 22 IVA scales are directly related to each other. In general, the findings show that this test has high and desirable validity and validity in the study of attention and accuracy and diagnosis of attention deficit and impulsivity disorder [15].

After collecting, data were analyzed by using SPSS software version 22, and also descriptive and inferential statistics were analyzed. Mean, and standard deviation indices were used to describe the data. In an inferential analysis, after testing the validity of the underlying assumptions, a multivariate analysis of covariance was applied by Spss.22.

**Results**

In the cognitive rehabilitation group therapy, 17 of them were male (56.7%), and 13 of them were female (43.3%). In the control group, 14 participants (46.7%) were male, and 16 (53.3%) were female.

Table 1 shows the mean and standard deviation of the cognitive skills scores in the experimental groups and the control group in the pre-test and post-test stages. The Wilks Lambda multivariate test is used to examine the effect of time on the mean, and the significance of this test indicates that the mean scores varied significantly over time. The results showed that Wilks Lambda was significant for the two groups of experimental and control group, meaning that the mean of working memory and attention-concentration was significantly different at different stages of pretest, posttest, and follow up (p <0.05). In the control group, the Lambda-Wilkes test was not significant, meaning that the mean working memory and attention-concentration in the three stages of pretest, posttest, and follow up did not change significantly in the control group and was approximately equal.

According to the contents of Table (2) in the relevant column, a significant level is observed that the difference between the experimental and control groups in terms of cognitive skills variables

**Table 1.** The mean and standard deviation of the main research variables

| Dependent variable      | Group          | Pre-test |       | Post-test |       | Follow-up |       |
|-------------------------|----------------|----------|-------|-----------|-------|-----------|-------|
|                         |                | M        | SD    | M         | SD    | M         | SD    |
| Working memory          | Rehabilitation | 40.45    | 36.17 | 60.59     | 77.8  | 20.56     | 00.9  |
|                         | Control        | 20.41    | 38.11 | 95.41     | 44.11 | 50.38     | 47.10 |
| Attention-concentration | Rehabilitation | 75.75    | 92.10 | 55.83     | 56.3  | 35.81     | 29.3  |
|                         | Control        | 25.74    | 80.8  | 30.74     | 89.8  | 45.74     | 80.80 |

**Table 2.** Test results of the effect of cognitive rehabilitation therapy on cognitive skills of adolescents living in welfare (working memory, concentration, and attention)

| Resource changes | SS      | Df | Ms      | F     | Sig    | Eta  | Follow-up step |        |      |
|------------------|---------|----|---------|-------|--------|------|----------------|--------|------|
|                  |         |    |         |       |        |      | F              | Sig    | Eta  |
| Working memory   | 800.288 | 1  | 800.288 | 24.10 | 0.0001 | 0.98 | 19.91          | 0.0001 | 0.98 |
| Error            | 11.00   | 18 | 222.65  |       |        |      |                |        |      |
| Focus-attention  | 450.00  | 1  | 450.00  | 13.10 | 0.0001 | 0.99 | 51.11          | 0.0001 | 0.99 |
| Error            | 50.24   | 18 | 36.13   |       |        |      |                |        |      |

(working memory and concentration-attention) is significant at the level of 0.001. Based on this, it can be said that the effect of rehabilitation therapy has increased cognitive skills in adolescents living in welfare in the post-test stage. Also, in the follow-up stage, according to the table in the significant column, it is observed that the difference between the experimental and control groups is significant in terms of the cognitive skills variable at the level of 0.001. Based on this, it can be stated that rehabilitation therapy has increased cognitive skills (working memory and concentration and attention) in adolescents living in welfare, in the follow-up stage.

### Discussion and Conclusions

This study aimed to evaluate the effectiveness of cognitive rehabilitation therapy on cognitive functions (working memory, concentration, and attention) of adolescents living in boarding schools in Tehran. The results showed that the difference between the experimental and control groups was significant in terms of cognitive skills variables (working memory and concentration-attention). Based on this, it can be said that the effect of rehabilitation therapy has increased cognitive skills in adolescents living in welfare in the post-test stage. Also, in the follow-up stage, according to the table in the significant column, it is observed that the difference between the experimental and control groups is significant in terms of cognitive skills variables. Accordingly, it can be stated that rehabilitation therapy has increased cognitive skills (working memory and concentration and attention) in adolescents living in welfare, in the follow-up phase.

The results of the present study are consistent with the results of Kessler and Lakayo [16], aimed to evaluate the effectiveness of rehabilitation programs on working memory and attention and improve academic and behavioral performance of 60 students aged 12 to 17 with learning disabilities and attention-deficit / hyperactivity disorder. The results of the study indicate the effectiveness of the program and rehabilitation therapy focused on working memory and focus - students' attention. Also, in neuroimaging studies conducted by Cicerone et al. [17]; Working memory rehabilitation

therapy has been shown to have a significant effect on neural activity in working brain-related brain regions and to improve their function. The results can be said to be consistent with the results of the present study.

The reinforcement of working memory in this study was done using a cognitive rehabilitation program. This program is a software program to improve the ability to store, transmit, update, and control information. In this program, the main purpose has been to strengthen working memory and its infrastructure, and the effectiveness of this program has been shown in previous research. One of them is Cernich's research [18]. This study aimed to evaluate the effectiveness of cognitive function enhancement on improving executive functions and reading components in children with reading difficulties. Moreover, improve executive functions in children with reading difficulties. Also, Wykes et al., showed that strengthening executive functions with this rehabilitation package can increase the stuttering intensity and basic cognitive functions in children and adolescents. Improve stuttering. It can be said that these two studies on the effectiveness of this program on executive functions have obtained results consistent with this study [19].

Although the association of depression with neurological disorders has not been well established, the direct association of depression with memory, training, and ability of planning is determined. Depression affects cognitive function negatively, and treatment of depression among adolescents has been associated with better cognitive performance [15]. Furthermore, the improvement of cognitive entities, including attention, concentration, and information processing, has reduced the anxiety of adolescents and thus has led to pleasure and increased confidence [16]. This study showed that cognitive rehabilitation could improve both depression and cognitive performance of adolescents, which is in line with previous reports. Concerning the cognitive functions, adolescents are usually affected significantly. The underlying reasons for decreased cognitive functions include the progressive nature of adolescence, long duration of the disease, physical disabilities, fatigue, and depression [20]. In the current study, we observed a significant improvement in adolescents' cognitive functions following cognitive rehabilitation

compared to the control group.

Different therapeutic techniques have been suggested to treat, control, or prevent cognitive dysfunction. Medical therapy, compensatory interventions, cognitive rehabilitation, and computerized cognitive rehabilitation are the suggested interventions. We found that cognitive rehabilitation could improve various aspects of cognitive dysfunction. This outcome was achieved through classes in which we tried to make patients compensate for their missed abilities by reinforcement of remained ones and also trying to develop their remained abilities, which could improve their self-esteem and confidence [21]. An important limitation of this study was the sample size. It is suggested that in order to increase the accuracy of generalization, this study should be performed for groups with a larger volume and with the third control group (another type of intervention). It is also recommended that computer-assisted cognitive rehabilitation therapy in medical centers be used by mental health professionals and other treatments to improve sleep problems and behavioral symptoms in children with attention-deficit / hyperactivity disorder.

#### Compliance with ethical guidelines

All ethical principles were considered in this research. The participants were informed about the purpose of the research and its stages. Informed consent was obtained from the subjects. They were also assured of the confidentiality of their information. Moreover, the subjects were free to withdraw from the study if desired. They were also informed that they would be provided with the results of the research.

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#### Authors' contributions

Conceptualization [Behnoush Hamedali]; Methodology [Javad Khalatbari]; Investigation [Saeid Malihi Alzakerini]; Writing – Original Draft [Mohammadreza Seyrafi]; Writing – Review & Editing, Author names [all author]; Funding Acquisition, [all author]; Resources, [all author]; Supervision, [Javad Khalatbari].

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#### Conflicts of Interest

The authors declare that they have no conflict of interests.

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