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The Effect of Attentionand Working Memory Improvement Training on Continuous Performance of Children with Attention Deficit Hyperactivity Disorder

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Background and Objective: Attention Deficit/Hyperactivity Disorder (ADHD) is among developmental disorders that has taken the attention of psychologists and psychiatrics from a long time ago. The present study aims to investigate the effect attention and working memory improvement on continuous performance of children with ADHD. Method: The present study was a quasi-experimental study and the sample included 44 children with ADHD who referred to psychiatric clinics of Babol and had the characteristics of interest and they were divided into test and control groups, each group contained 22 subjects. Their performance at the pretest was evaluated

using Continuous Performance Management Software. Then, each group member exposed to training with attention and working memory improvement application for 20 sessions of 30 minutes (7 weeks, 3 times a week, 30 minutes). After the training period, posttest was administered using the same software for both groups.Findings: The results of analysis of covariance showed that despite increased continuous performance of both groups at posttest, increased continuous performance in the test group was higher than the control group. Therefore, attention and working memory improvement training was effective for continuous performance of children with ADHD.

Conclusion: Attention and working memory improvement training and similar trainings can function as a therapeutic method beside drug therapies or they can be used instead of drug therapies.

Keywords: ADHD, continuous performance, attention and working memory improvement

Introduction

Attention Deficit/Hyperactivity Disorder (ADHD) is one of the most common developmental disorders that about 7% of children and adolescents suffer from it [1]. This disorder is a neuropsychological disorder that is characterized by abnormal signs of inattention, shaking, and restlessness and is observed among about 4 to 12% of school-aged children and continues until adolescence and later stages [2]. Epidemiological studies show that 4 to 5% of adults suffer from ADHD [3]. The prevalence of ADHD is also dependent on gender and researchers estimate that males are exposed to this disorder 3 to 10 times more than the females [4-6].

The frequency of ADHD in the United States is reported about 2-6% and several studies have reported its prevalence more than 17% [7]. Talaei et al. (2010) stated that the prevalence of ADHD among Iranian boys (7-9 years old) in Mashhad city is more than other countries, so that inattention (4.62%), shaking (5.32%), and a combination of both (5.32%) were reported for them [8]. Also, Habrani et al. [7] in their study in Mashhad stated that the prevalence of ADHD among preschool children is 12.3% that its prevalence among males is 18.1% and among females is 6.7%. According to the report by the National Institute of Mental Health (NIMH), ADHD is one of the most common mental disorders among children and adolescents and in an annual estimation, it has been observed among 18 to 44 years old people.

Fifty nine to 87% of children with ADHD at least suffer from comorbidity and 20% have three or more comorbidity signs. ADHD comorbidity includes learning disability (12-25%), speech disorder (30-35%), lack of social adaptation such as autism (10%), mode disorder (15-20%), anxiety disorder (20-25%), imbalance (60%), obesity, and insomnia. Also, it has been estimated that these people in their future life will be exposed to isolation (20%) and drug abuse (15%) [9].

As can be observed, this disorder, in addition to its fundamental problems including hyperactivity, shaking, and inattention, has other major problems that involve children and parents. Children with ADHD do not report social problems significantly but parents and teachers confirm problems [10]. It is obvious that this disorder damages children, parents, and society.

Egeland et al., in their study showed that working memory training influences psychomotor speed and improves reading and mathematics [11].

The most famous test to identify disorder in children is Continuous Performance Management Test. This test was designed by Razold et al. (1956) and became famous quickly in the 1990s. This test was used as the most powerful laboratory method to evaluate hyperactive children with attention deficit. This test, in addition to research applications in the clinic, is used as rehabilitation and attention assessment tool [12]. This test requires careful attention during a continuous task and avoidance of shaking responses [13]. First, this test was used to measure brain lesion but over time, its application expanded [14].

ADHD is a chronic disorder and if it is not diagnosed and treated immediately, it leads to individual and social disabilities. Also, costly drug therapy and its side effects motivated the researcher to investigate the effect of working memory training on continuous performance of children with ADHD.

Materials and Methods

The present study is a quasi-experimental study and it was conducted at pediatric psychiatric clinics in Babol and each clinic was managed by a psychiatric and at least a psychologist. All patients who referred to these units had medical file and were revisited at least every two months. The population included all children referring to psychiatric clinics in Babol who were diagnosed with DSMIV and ADHD according to the diagnostic criteria and the psychologist and were under medical therapies at least for 30 days and their parents consented to participate in this study. In this regard, 44 subjects were selected as the sample based on purpose sampling and divided into two groups of test and control, each containing 22 subjects. The research units had the following characteristics: 1. According to the evidences and the doctor's opinion, they were suffering from ADHD; 2. Their medical therapy was started at least 30 days ago; 3. They were between 7 and 12 years old; 4. Their parents were willing to participate in the study; 5. They could read and write and were familiar with computer; 6. They did not have any other problems such as mood disorders, anxiety, and conduct and coping disregard; 7. They had average IQ according to Wechsler's Intelligence Scale. Exclusion criteria included: 1. Failure to understand the educational materials for the test; 2. Suffering from a certain disease where they did not have the necessary conditions to continue the procedure both physically and mentally; 3. They migrated from their place of residence for any reason. Subjects, according to these conditions were assigned into test and control groups based on purpose sampling. The measurement instrument in this study was the Continuous Performance Test. In this test, 150 stimulants were presented where 20% was the objective stimulant (the stimulant that the subject responded to it). The presentation period for each simulant was 200000 milliseconds and the interval between two simulants was 1 second. The simulant type (number or figure) was selected at the personal information page and each objective simulant was selected at the results page. After entering the personal information of the subject in the personal information section, the test was administered. At the beginning, necessary explanations were displayed on the screen to let the experimenter clarify them for the subject. The test was started when the subject was ready. The test duration, considering the experimental stage was 200 seconds.

To implement this plan, the research plan was explained to the authorities of psychiatric clinics of Babol by the researcher and the researcher explained the objectives. After receiving the necessary permissions, samples were taken from children who were referring to the psychiatric clinics and were suffering from ADHD based on DSM-TV-TR criteria and diagnosis by the psychiatric and were under drug therapy at least for a month. Sample size was estimated after pilot study and with respect to previous studies (22 subjects in each group). Then, subjects were homogenized in terms of demographic characteristics (e.g. gender and age) and were assigned into test and control groups. Then, the performance of research groups was measured using Continuous Performance Management Software at the pretest. At the next stage, subjects were trained individually by attention and working memory improvement application for 20 sessions (seven weeks, three times a week, 30 minutes). After the training period, posttest was administered using the same software. Attention and working memory improvement training application include three parts of auditory memory, visual memory, and stabilization. Auditory memory and visual memory have forward and reverse memory training capabilities. Each section of forward and reverse training includes three subsections of letters and figures. Each section such as numbers, letters, and figures is divided in terms of difficulty level from 1 to 9. After selecting the difficulty level, what the subject hears or sees is indicated in difficulty levels of 1-9 in three rows. Also, in letters' section, 9 letters with similar pronunciations and in figures' section, 9 figures are indicated. The subject should answer what he is heard or saw with the computer mouse; for this purpose, inserts in the forward section and answers in the reverse section. For each correct answer, the subject receives 20 points and for each false answer, 10 points are deducted. After 5 correct answers, the subject goes to the next stage. The stabilization section divides into auditory and visual sections, so that each section divides into numbers, letters, and figures. After selecting each section, 9 cells are indicated. By selecting the difficulty level, numbers or letters or figures are heard or saw in these cells. Then, the subject should answer what is heard or saw that is randomly asked by the application. Again, the subject receives 20 points for each correct answer and for each false answer, 10 points are deducted.

Findings

Forty four patients in two research groups were studied. The number of males and females in both groups was similar, so that in each group, there were 19 males and 3 females. Average age in the test group was 8.96±1.56 and in the control group was 9.36±1.47 and average IQ in the test group was 110.86±11.67 and in the control group was 110.45±9.87. In Table (1), the demographic characteristics of both groups are presented.

Table 1. Frequency distribution of demographic characteristics

Demographic characteristics	Test group		Control group	
	Frequency	Percentage	Frequency	Percentage
Gender				
Male	۱۹	۸۶/۴	۳	۱۳/۶
Female	۱۹	۸۶/۴	۳	۱۳/۶
Age (year)				
7-9	۱۶	۷۲/۷	۶	۲۷/۳
10-12	۱۴	۶۳/۶	۸	۳۶/۴
IQ				
90-100	۵	۲۲/۷	۴	۱۸/۲
101-110	۷	۳۱/۸	۹	۴۰/۹
111-120	۵	۲۲/۷	۵	۲۲/۷
Above 120	۵	۲۲/۷	۴	۱۸/۲

Table (2) shows the results of executive functions for test and control groups at pretest, posttest, and posttest after removing pretest's effect. The resulted mean indicates increased posttest continuous performance compared with pretest in both test and control groups where the highest increase was observed in test group.

Table 2. The results of continuous performance of research groups at pretest and posttest

Stage	Test	Control
Pretest	143/27±5/700	142/59±5/133
Posttest	148/45±1/371	145/45±4/758
Posttest after removing pretest's effect	148/37	145/55

Table (3) shows the analysis of covariance test. To administer this test, first, homogeneity of slopes (F = 0.748 and p = 0.381) and homogeneity of error variances (F = 0.127 and p = 0.756) were investigated and confirmed. The results of this test indicated that controlling the 16.7% of pretest scores relationship of continuous performance (p<0.01) and according to calculated F, a significant difference existed between pretest scores of continuous performance in both research groups. The difference shows that 16.9% of the observed dispersion is the result of attention and working memory improvement training.

Table 3. The results of analysis of covariance for posttest mean scores of research groups in continuous performance test controlling pretest

Source of changes	Sum of squares	Degree of freedom	Mean of squares	F	Significance level	Eta square	Statistical power
Pretest	86/198	1	86/1988/244		0/006	0/167	0/800
Group	87/111	1	87/1118/331		0/006	0/169	0/805
Error	428/711	41	10/456				
Total	950822/000	44					

Discussion

The role of executive function deficit in ADHD is very important [15]. Therefore, working memory training is one of the well-known neuropsychological treatments that has presented wonderful findings [15-17]. In this study that investigated the effect of attention and working memory improvement training on continuous performance of children with ADHD who referred to psychiatric clinics in Babol from 2013 to 2014, the effect of attention and working memory improvement training on continuous performance of children with ADHD was confirmed. Although the results showed that continuous performance at pretest in control group is increased, comparing the mean difference between groups showed that this difference was significant at the level of 99%.

In a study by Abdi et al., it was shown that computer games training can improve working memory, attention, and cognitive flexibility [18]. Also, Shinaver et al., in their study concluded that working memory training can increase the capacity of working memory and attention [19]. Wang et al., in their study showed that ADHD signs improve after 6 months of continuous performance. Berger et al., showed that four signs of attention, time, hyperactivity, and shaking improved in the test group [21].

Also, Narimani et al., in their study proved that working memory and attention maintenance improve with training [22].

Riostaman et al. [23] and Sarli et al. [24] showed that computer-based training can improve the performance of children with ADHD and this is consistent with the results of the present study. According to this finding, it seems that attention improvement and working memory training and similar procedures can function as a complementary method and even an alternative for drug therapies. Due to time limitations and since this study lacked long-term follow-up, sessions were limited. Therefore, it is suggested to conduct future studies with more sessions on larger samples and characterize different therapeutic effects according to the disorders.

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