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THE MOST EFFECTIVE INTERVENTION FOR ATTENTION DEFICIT-HYPERACTIVITY DISORDER: USING CONTINUOUS PERFORMANCE TEST

Sayyed Davood Meftagh[1], Arash Najimi[2], Norallah Mohammadi[3], Ahmad Ghanizadeh[4], Changiz Rahimi[3] & Mehdi Mohammad Amini[5]

[1]Department of Psychology, Payame Noor University, Iran
[2]Department of Health Education and Health Promotion, School of Health, Isfahan University of Medical Sciences, Isfahan, Iran
[3]Department of Clinical Psychology, School of Education and Psychology, Shiraz University, Shiraz, Iran
[4]Department of Psychiatry, Research Center for Psychiatry and Behavioral Sciences, Shiraz University of Medical Sciences, Shiraz, Iran
[5]Department of Clinical Psychology, School of Education and Psychology, University of Mohaghegh Ardabili, Ardabil, Iran

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SUMMARY

Background: *This study compares the effectiveness of three treating methods including behavioral mother training (BMT), Verbal self-instruction to the children (VSI), and pharmacotherapy in children with attention deficit-hyperactivity disorder (ADHD) using the continuous performance test (CPT).*

Subjects and methods: *In this semi-experimental study, 51 elementary students were identified in a boys' school in Shiraz (age 8-10) with attention deficit-hyperactivity disorder in a pilot study (among 1760 students). They were randomly divided into three groups; BMT, VSI, and control group. Moreover, 22 students were selected with ADHD among the clients in Hafez hospital. They were chosen by the availability method and they were put into the Pharmacotherapy group. Data collection tools were the Child Symptoms Inventory (CSI-4) and the continuous performance test. All of the groups were evaluated after the intervention and in post-test and also 2 months later in follow up.*

Results: *The treatment type (group) showed statistically significant difference in the result of CPT on severity of attention-deficit and in the number of correct responses (P=0.01), yet on the hyperactivity symptoms, there was no significant difference between the different treatment groups (P=0.08). The time factor shows a significant difference among the different groups (p<0.001).*

Conclusions: *Comparison of the various treatments of ADHD indicates that pharmacotherapy can improve the severity of attention deficit and the number of correct answers of children with ADHD.*

Key words: *ADHD - behavior therapy - cognitive therapy – pharmacotherapy - continuous performance test*

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INTRODUCTION

Attention deficit – hyperactivity disorder (ADHD) is a neuro– behavioral disorder that disturbs the child's abilities to maintain attention and inhibitions corresponding to his/her age in cognitive–behavioral situations. The dominant form of this disorder is a stable disability in attending and or displaying hyperactivity – impulsivity pattern (Ohnishi et al. 2010).

This disorder usually leads to conflict with authorities in school and at home so that these children will suffer from disillusionment and worthlessness. Many imprisoned adolescents suffer from ADHD (Ghanizadeh et al. 2011). Their quality of life is heavily impacted (Jafari et al. 2011). Meanwhile, ADHD is not well studied in Iran (Ghanizadeh & Akhnodzadeh 2010). In Iran, parents, teachers and general physicians' knowledge about this disorder is limited (Ghanizadehzade & Zarei 2010, Ghanizadeh 2008). Due to variability of symptoms in these individuals, sometimes parents think that all obtrusive behaviors of the child are intentional. In spite of effective remedies applied for this disorder, more than 80% of children with ADHD have clear symptoms of this disorder until adolescence (Shiels & Hawk 2010, Daly et al. 2007).

The prevalence of this disorder was reported 2 to 9% in the world and 10.1% in Iran (Fabiano et al. 2009, Ghanizadeh 2008), while the boy to girl ratio in the clinical population of this disorder was reported as between 2: 1 to 6:1 (Biederman et al. 2002). There are three treating methods as the main approaches used in treatment interventions for ADHD: Behavioral, cognitive- behavioral, and medical (Johnston et al. 2008, So et al. 2008, Fehlings et al. 1991).

Although some scholars believe that pharmacotherapy (medical approach) is the most successful treatment for this disorder and methylphenidate (Ritalin) is known as an effective stimulant medicine on 80% children with ADHD (Capute & Accardo 1991), there are still some limitations such as side effects of pharmacotherapy, instability of treatment effects after pharmacotherapy, and 20-30% of non responsive

ADHD children to stimulus medicine (Aagaard & Hansen 2011, Toplak et al. 2008, Danforth et al. 2006), lead to a significant number of studies into the psychological treatment for these children (Johnston et al. 2008, Froehlich et al. 2007). These three approaches - medical, behavioral and cognitive – behavioral - were identified as the most important therapeutic approaches in ADHD, and their effectiveness have been verified separately and together; however, considering all the literature available, there was no comparison of these three treating methods in the same research in the Iranian community. This causes parents to be doubtful in selecting the most effective and efficient treatment in ADHD, and also cause the rejection of some treatments (eg. medication), or replacement of this treating method with others. Moreover, regardless of methodological differences, many studies compared effectiveness and efficiency of different interventions by using parents' report about their children' ADHD symptoms. Therefore, it is necessary to focus on the children rather than the parents to examine the most effective treatment. In order to do this, this study measures and evaluates symptoms of inattention and impulsivity – hyperactivity by using continuous performance test and finally it compares behavioral mother training, children verbal self-instruction interventions and pharmacotherapy.

SUBJECTS AND METHODS

Participants

In this semi–experimental study, 73 pairs of ADHD children (8-10 years) and mothers have been studied in four groups (BMT, VSI and pharmacotherapy and control groups). Two methods of sampling have been used in order to select the subjects: multi-stage sampling and accessible sampling. Among the four educational areas in Shiraz (Shiraz, as the capital of Fars province, is one of largest cities in Iran. This city is located about 924 km south of Tehran and it has a population of 1,214,808), two areas (areas 2 and 4) were randomly selected, and then among the male schools in these areas, 15 elementary schools have been selected at random. All students studying (1760 students) in the 3rd and 4th grade have been evaluated by the ADHD symptom inventory (Child symptoms inventory, teacher form).

The mothers of 134 students with ADHD (based on the teacher questionnaire) were requested to fill out the parent form questionnaire. Then, clinical interviews were run for all 114 parent and children who had been diagnosed with ADHD in both the teacher form and parent form questionnaire. Finally, Among the 108 students who were identified with ADHD, 51 were randomly selected and placed in three groups of BMT, VSI and control groups completely by random. To observe research ethics, accessible sampling has been used in the pharmacotherapy group. Among 70 third and fourth grade students with ADHD (based on psychiatrist diagnosis) who referred to Hafez Hospital and Shahid Motahary clinic and who were also willing to take medicine, 23 were chosen randomly and were placed in the pharmacotherapy group (The groups were matched according to ADHD symptom severity based on the child symptoms inventory).

Measures

The data collection tools were the child symptoms inventory (CSI-4) and the continuous performance test. The teacher Form (CSI-4) was used for screening and sample size selection and the parent form (CSI-4) was used to evaluate the symptom severity. CSI-4 scoring is done in two ways: 1) the screening cut-off point scoring method, 2) the Symptom severity scoring method. In scoring this screening approach questionnaire it is necessary to score zero those participants who answer to statements with the option of ‘never’ and ‘rarely’, and to score one if the answer is ‘sometimes’ and ‘more often’. In symptom severity scoring methods, the options never, rarely, sometimes, and often will be scored 0-3 respectively. The symptom severity score will be obtained by the sum of the 1 – 9 expressions and 10 - 18 expressions.

In this study, both scoring methods have been used. The cut-off point scoring method has been used for the screening the sample and the symptom severity scoring have been used to measure the symptom severity. Validity of this inventory was confirmed in several studies (Sprafkin et al. 2002).

The Continuous performance test (CPT) was validated and designed as a method for detecting and studying brain damage by Rosvold (Woodford 2003) and now it is used as a method for measuring attention sustainability and as well as inhibitory – impulsivity states especially in children with ADHD.

This test is characterized as the most important and common laboratory test in ADHD assessment. In this test, in addition to deficits of impulse control, deficits of attention control in ADHD patients can be measured and explained by their performances in CPT (Winstanley et al. 2006). In the present study, the Persian – form of CPT was used. This test has the following characteristics: 1) it is performed by software and a minimum of familiarity with a computer is needed for performing this test, 2) this test consists of 150 stimuli. 30 of them are target stimuli, 3) The interval between two stimuli in this test is 500 ms and the presenting time of each stimulus is 150 ms, 4) both omission error and commission error are marked by the computer. Moreover, the computer reports the number of correct responses for every subject, 5) omission error refers to inattention and commission error refers to subjects' impulsivity and the number of correct responses also shows the improvement level of the subjects' performance in this test.

Procedure

Before intervention, all subjects were informed about the aims of the present study and all individuals were presented with a permission form. Thus, all subjects of the research project were informed and their consent was obtained. All children in BMT, VSI, pharmacotherapy and control groups were assessed before intervention by CPT, and then the intervention was performed in the BMT, VSI and pharmacotherapy groups. All children in the three groups were assessed by CPT two months after the intervention and two months after in the follow – up stage (4 months after pre- test).

Intervention

Behavioral Mother Training Treatment Program: In designing the behavioral mother training program, Barkley (1997) behavioral parent training (BPT) was used. Therapeutic steps of this training package includes: explain ADHD, shaping a positive behavior through reinforcement, not reinforcing undesirable behaviors, a formal system of training points and chips(token) in order to condition the child to obey, parent training for using the time out method, using the daily school behavior report card, anticipating the children's misbehavior in public places. The training intervention in this group was performed in ten educational sessions (Each session was about 90 min) during 10 weeks.

Children's Verbal Self-instruction Training Program: training program of VSI has been designed based on Meichenbaum (1978). The elements in this intervention are as follows: A) Directed discovery verbal self-instruction that includes identifying problems, determining the logical consequences and problems identification as the main causes of outcomes, identifying beneficial solutions, learning the self-instruction sentences; B) Didactic verbal self-instruction that includes teaching five-step problem solving strategy in verbal form; C) Faded rehearsal verbal self-instruction that includes task selection, cognitive modeling, overt external guidance, overt self- guidance, modeling of faded overt self- guidance, child's practice of faded overt self- guidance, modeling of covert self-instruction, child practice of faded covert self-instruction. The training intervention in this group was performed in ten educational sessions (Each session was about 60 min) during 10 weeks.

Pharmacotherapy: ADHD children in the pharmacotherapy group have received 20-30 mg methylphenidate per day based on the weight (20 mg for weight below 30 kg and 30 mg per day for weight over 30 kg). Two doses of the medicine were taken usually in the morning and afternoon. Pharmacotherapy did not stop in any of the post-test steps and follow-up tests.

Data analysis

In order to analyze data, SPSS software (ver. 17) and descriptive statistic, General linear models and Bonferroni post hoc test were used. The significance level of α=0.05 was considered for all tests.

RESULTS

Out of 73 subjects, 62 of them finished the study (15 participants in BMT, 15 participants in VSI and 15 participants in the control groups and 17 in pharmacotherapy group). The mean age of children and mothers participated in the study were 8.98±0.77 and 35.81±3.6 years, respectively. There were no significant differences among the study groups regarding age, family, and education (P>0.05).

The results showed that the time factor had significant effect on subjects' omission error, commission error and their correct responses while the treatment factor (group) showed significant change in omission error and correct responses, furthermore, interactive effect of treatment type and the time factor was statistically significant based on omission error (F=6.05, P<0.001) commission error (F=3.77, P=0.004) and the number of correct responses (F=10.66, P<0.001) (Table 1).

Based on Bonferroni post hoc test, there was a significant difference between the pharmacotherapy and control groups on omission error and the number of correct responses (P=0.01). Comparing other groups, there was no significant difference in results of CPT (Table 2).

In Table 3, concerning omission error, there were significant differences in BMT and pharmacotherapy groups in post test – pretest (P=0.01, P=0.04 respectively) and follow up – pretest (p=0.03, P=0.01 respectively). In the VSI group, there were significant differences between post test-pretest (P<0.001) and follow up-post test phases (P=0/006). Concerning commission error in BMT and pharmacotherapy groups, the results showed a significant difference in post test – pretest (P=0.004 and P<0.001 respectively) and follow up – pretest (p=0.007 and p<0.001 respectively). There was significant difference in the VSI group between post test– pretest phases (P<0.001).

Based on the subjects' correct responses, there were significant differences in the BMT and pharmacotherapy groups in post test– pretest and follow up – pretest phases (p<0.001), while the results showed significant difference in pretest – post test (P<0/001) and follow up – post test (P=0.04) in the number of correct responses in VSI. In the control group, the results of CPT showed no significant difference considering omission error, commission error and the number of correct responses during the time and in none of the stages.

Table 1. The main and interactive effects of time and treatment on omission error, commission error and correct responses in CPT

Variable	Omission error			Commission error			Correct responses		
	df**	F	P†	df**	F	P†	df**	F	P†
Group	3	3.75	0.01	3	2.31	NS*	3	3.81	0.01
Time	2	12.11	<0.001	2	40.70	<0.001	2	65.89	<0.001
Group * Time	6	6.05	<0.001	6	3.77	0.004	6	10.66	<0.001

*NS= Not Significant; **df= Degrees of freedom; † P value was calculated using repeated-measures test

Table 2. Bonferroni Post Hoc Test for Paired Comparison in Four Groups

Groups		Omission error		Correct responses	
		MD (Mean ± SD)	P	MD (Mean ± SD)	P
BMT	VSI	-0.67 ±1.03	NS	1.33±2.18	NS
	Pharmacotherapy	0.31±1.01	NS	-1.16±2.12	NS
	Control	2.8±1.03	NS	5.64±2.10	NS
VSI	Pharmacotherapy	0.97±1.14	NS	-2.49±2.12	NS
	Control	0.26±1.09	NS	4.31±2.18	NS
Pharmacotherapy	Control	3.11±0.98	0.01	6.8±2.18	0.01

MD: Mean Differences among groups of study; NS= Not Significant

Table 3. Paired Comparison for the Effect of Time Factor Based on omission error (Inattention), commission error (Impulsivity) and the number of correct responses in CPT

Groups	Time	Omission error		Commission error		Number of correct responses	
		MD (Mean ± SD)	p	MD (Mean ± SD)	p	MD (Mean ± SD)	p
BMT	pre test- posttest	-3.00±0.85	0.01	-6.27±1.58	0.004	9.53±1.6	<0.001
	follow-pre test	0.2±0.93	NS	1.60±1.25	NS	-2.06±1.48	NS
	follow-posttest	-2.80±0.98	0.03	-4.66±1.24	0.007	7.67±1.76	<0.001
VSI	pre test- posttest	-4.13±0.75	<0.001	-5.80±1.14	<0.001	9.93±1.30	<0.001
	follow-pre test	3.46±0.91	0.006	2.80±1.46	0.23	-6.26±2.20	0.04
	follow-posttest	-0.66±0.96	NS	3.01±1.60	NS	3.66±1.94	NS
Pharmaco therapy	pre test- posttest	-3.02±0.14	0.04	-6.82±1.37	<0.001	10.00±1.16	<0.001
	follow-pre test	-0.7±0.37	NS	-0.41±0.42	NS	0.94±0.31	0.02
	follow-posttest	-3.7±1.15	0.01	-7.23±1.38	<0.001	10.94±1.18	<0.001
Control	pre test- posttest	1.46±0.88	NS	-1.4±0.68	NS	-0.06±0.59	NS
	follow-pre test	-0.13±0.86	NS	-0.08±.73	NS	0.2±0.52	NS
	follow-posttest	1.33±0.57	NS	1.46±0.63	NS	0.13±0.46	NS

Bonferroni Post Hoc Test was used; MD: Mean Differences in post test, pre test and follow up; NS= Not Significant

DISCUSSION

Omission error occurs when subjects do not respond to target stimulus and it implies that subjects had problems in inferring target stimulus. This error is interpreted as a problem in sustaining attention and it refers to inattention to stimuli. In other words, not being responsive to target stimuli by subjects reflects their problems in the attention process (Woodford 2003).

The results showed that the intervention method had a significant effect on the subjects' intensity of inattention and pharmacotherapy had a significant effect on decreasing inattention (omission error) of subjects in the Persian form of CPT compared to the control group. So it can be concluded that pharmaco-therapy is the most effective method in decreasing the subjects' omission error on the basis of CPT that is representative of their inattention.

Moreover, the time factor also had a significant effect on subjects' omission error in CPT, so BMT was influential and its effects continue to the follow up stage, but the therapeutic effects of VSI were displayed rapidly in the post test stage but they did not continue to the follow up stage, while pharmacotherapy showed its remedial effects with delay in the follow up stage. Many studies verified the effectiveness of pharmacotherapy on the subjects ' omission error and inattention of children with ADHD in CPT (Hyun Han et al. 2009, Wilson et al. 2006).

Pietrzak et al. (2006) in a study of 40 relevant placebo-controlled studies, has referred to improving cognitive functions after methylphenidate treatment in

over 63.5% of Published studies. In Iran, Khoushabi et al. (2006) referred to non-effectiveness of parent management training intervention on inattention of children with ADHD. However in this experimental study, mother behavioral training is mentioned as one of the best complementary treatment methods.

Fehlings et al. (1991) also indicated that cognitive-behavioral approaches such as VSI had no significant effect on improvement of private speech and performance of children. Although based on parental report, a significant reduction is mentioned in children's activity levels following the cognitive - behavioral therapy.

Some previous studies referred to effectiveness of psychosocial treatments on decreasing subjects' omission error (Corkum & Siegel 1993, Hall & Kataria 1992, Meichenbaum & Goodman 1971). Some of the main reasons for such differences are difference in target groups (study on two gender), methods used in the interventions and less time of follow up.

In CPT, commission error occurs when subjects respond to non – target stimulus. This type of response is an indicator of weakness in inhibiting impulses. This error reflects problems related to impulsivity. This study showed no significant difference between effectiveness of the studied groups in terms of impulsivity of subjects in the Persian form of CPT. While time factor showed significant effect (difference) between three stages of evaluation in each groups, so that although three intervention methods demonstrated their effects in post test stage rapidly, the therapeutic effects of the VSI method were eliminated in the follow up stage while the therapeutic effects of two other methods continue to the follow up stage.

There are some reports of no significant difference between various interventions on subjects ' commission error and their impulsivity (Woodford 2003, Fehlings et al. 1991), while some studies tried to verify effectiveness of pharmacotherapy methods (Wilson et al. 2006, Pietrzak et al. 2006, Broyd et al. 2005, Zillessen et al. 2001) and psychosocial methods (Arco et al. 2004, Corkum & Siegel 1993, Hall & Kataria 1992), especially the effect of VSI on decreasing commission errors and impulsivity of children with ADHD in CPT.

It seems when improvement rate is evaluated based on commission errors, effectiveness of treatment decreases too, so that even the pharmacotherapy group showed no significant effectiveness compared to the control group. Considering the number of correct answers, the pharmacotherapy group showed significant effectiveness compared to the control group in increasing and improving the number of the subjects' correct responses in CPT. This is consistent with the results of studies that tried to verify effectiveness of pharmacotherapy by measuring children with CPT (Zillessen et al. 2001, Klorman et al. 1988, Rapport et al. 1986). Broyd et al. (2005) by investigation of methylphenidate effects through event related potentials and skin conductance level reported that methylphenidate improves a defect of inhibition response of children with ADHD.

In the present study, the time factor showed significant effect on the subjects' correct responses in CPT. The effects of pharmacotherapy and BMT were not only demonstrated rapidly in post test but they continued to the follow up stage, however VSI method demonstrated its effects only in the post test stage and these effects were eliminated in the follow up stage. Woodford (2003) verified that VSI did not lead to improvement of private speech and performance in CPI-II test. Whenever subjects' correct responses are used as an indicator of improvement and development of children' performance in this test , the findings suggest that pharmacotherapy is the most effective method in CPT and that BMT and VSI methods had no significant effect on improvement of subjects' correct responses.

The present study has some limitations, such as application of semi-experimental research design due to selection of members of pharmacotherapy group by available random method in order to observe moral codes, and also reduction of the number of subjects due to failing to attend and participate in the treating sessions.

CONCLUSION

According to continuous performance test, Pharmacotherapy can improve omission error (inattention) and subjects' correct responses of children with ADHD. In addition, pharmacotherapy has revealed its therapeutic effects faster than other treating method and the effects have remained until follow up. It seems that when there is no possibility of using combination therapy, Pharmacotherapy is more effective than VSI and BMT methods.

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Correspondence:
Arash Najimi
Department of Health Education & Health Promotion , School of Health
Isfahan University of Medical Sciences, Isfahan, Iran
E-mail: a_najimi@hlth.mui.ac.ir