

Barkley's Parent Training Program, Working Memory Training and their Combination for Children with ADHD: Attention Deficit Hyperactivity Disorder

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Objective: The aim of the current study was to examine the effectiveness of Barkley's parent training program, working memory training and the combination of these two interventions for children with Attention deficit hyperactivity disorder (ADHD).

Methods: In this study, 36 participants with ADHD (aged 6 to 12 years) were selected by convenience sampling. Revision of the Swanson, Nolan and Pelham (SNAP) questionnaire (SNAP-IV), Child Behavior Checklist (CBCL) and clinical interviews were employed to diagnose ADHD. Wechsler Intelligence Scale for Children-Fourth Edition was also implemented. The participants were randomly assigned to the three intervention groups of Barkley's parent training program, working memory training and the combined group. SNAP-IV and CBCL were used as pre-tests and post-tests across all three groups. Data were analyzed using MANCOVA (SPSS version18).

Results: There was a significant difference ($p < 0.05$) in the decline of attention deficit and hyperactivity /impulsivity symptoms between the combined treatment group and working memory training group and also between the combined treatment group and the parent training group in SNAP. In terms of attention problems (experience-based subscales) of CBCL, there was a significant difference ($p < 0.001$) between the combined treatment group and working memory training group. Furthermore, compared to the working memory training and parent training groups, the combined group demonstrated a significant decline ($p < 0.01$) in clinical symptoms of ADHD (based on DSM).

Conclusion: It was revealed that combined treatment in comparison with the other two methods suppressed the clinical symptoms of ADHD more significantly.

Keywords: Attention deficit hyperactivity disorder (ADHD), Parent training program, Working memory training, Combined treatment

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Attention deficit-hyperactivity disorder (ADHD) is a neuropsychiatric disorder of childhood which is associated with inattention, impulsivity and hyperactivity (1-4). It is estimated that 3 to 7 percent of school- aged children are affected by ADHD (2). Symptoms of ADHD tend to impact various aspects of the individual's functioning and development (5, 6). Indeed, children with ADHD might have various behavioural impairments, low self-confidence, aggression and learning problems (3, 4, 7). Furthermore, most children are also affected by other comorbid disorders (7, 8). High prevalence of ADHD, its behavioural outcomes and common occurrence with comorbid disorders greatly complicate the treatment of children with ADHD (2, 9).

Various Methods of treatment have been proposed so far to reduce ADHD symptoms. These methods are

globally classified as medical and psychosocial treatments (10-12). One of the treatment methods in psychosocial domain involves parent training which is currently considered as an indispensable component of medical interventions (3, 13, 14). It is due to the significant correlation existing between inappropriate family functions and the symptoms and problems of children with ADHD (15-17). Previous research revealed that children with ADHD exhibit more disruptive behaviours and less obedience in comparison with their normal counterparts (18). In contrast, their parents often display a passive behaviour (19), use physical discipline more likely than their counterparts (20). These parents also have more tendencies to control, abandon their children or treat them less warmly (5, 6, 19, 21,-24). Consequently, the association between children's undesirable behaviour and parents' inappropriate strategies persists cyclically

(5, 6, 16, 25). The research on the effectiveness of parent training programs demonstrates that these programs result in reducing the core symptoms of ADHD (26-28), and they also lead to the decline of behavioural problems, the enhancement of attachment and the improvement of the child's social skills and class behaviors (3, 4, 28, 29). In addition, as a result of parent training, the risk of academic failure in children and criticism by parents decrease, and also the self-esteem and the mood of children tend to improve (2). Recently, research has revealed that parent training is an evidence-based and effective intervention for ADHD (9, 10).

Another psychosocial treatment for reducing ADHD symptoms focuses on the role of executive functions in ADHD (30-36). One of the components of executive functions is working memory which allows temporary storing and manipulation of the data (36). The association between working memory deficit and ADHD has been substantiated by Barkley and Rapport (31, 38, 39, 40-46). Many researchers investigated the effects of working memory training on improving the symptoms of this disorder. One of these studies, conducted by Klingberg et al. (2002), indicated that children's performance improved over five-week task training on working memory. In addition, the efficiency of these children over untrained tasks of spatial-visual working memory increased significantly (47). In another research, Klingberg et al. (2005) found that these trainings for ADHD children not only led to the decline of symptoms, but also resulted in the improvement of performance in inhibition and reasoning (48). In a similar vein, Duarte et al. (2012) revealed that working memory training considerably reduces risky decision making in individuals with ADHD (49). Neurological and brain imaging studies have also demonstrated that working memory training causes an increase in the activities of the prefrontal area of the brain (50, 51). Overall, the findings of various studies verify the effectiveness of working memory training as an evidence-based intervention for children with ADHD (43, 47, 48, 52-55).

In sum, various effective interventions have been identified so far for ADHD treatment. Nevertheless, achieving a treatment with maximum efficiency needs more research in this realm. In this regard, previous research suggests that decreasing the multidimensional problems associated with ADHD and meeting the specific needs of patients is feasible through combining a number of treatment methods (3, 10, 56-60). Reviewing the existing literature demonstrated that various combined treatments to date have been examined in some studies. Yet, the effectiveness of the combined methods of working memory training and parental training, each of which provided substantial research evidence, has not been investigated so far. Employing parent training targeted at environmental causes along with working memory training influencing neurobiological factors set the groundwork

for utilizing these two techniques in combination with each other. Therefore, the aim of the current study was to examine the effectiveness of Barkley's parent training program, working memory training and the combination of these two interventions for children with ADHD.

Material and Methods

Participants

The present study utilized an experimental design via pre-test and post-test in three groups. The participants were selected from the child psychiatry clinic of Ibn-e-Sina psychiatric hospital in Mashhad using convenience sampling. The population included 36 children with ADHD and their mothers. This sample size was calculated using G power software version 3.1 with $\alpha = 0.05$ and a high effect size based on the study of Klingberg et al. (47).

Inclusion and Exclusion Criteria were as follows:

Inclusion criteria: 1-Children aged 6 to 12 years; 2-Diagnosis of ADHD based on the DSM-TR criteria by a child and adolescent psychiatrist; 3- Taking Ritalin and 4-Having normal IQ score; 4- Signing the consent form by mothers .

Exclusion criteria: 1-Children who were taking any other medications were excluded from the study .

The present sample was randomly assigned into three research groups as follows: 1) parent training group for 12 mothers; 2) working memory group consisting of 12 children; 3) the combined group comprising 12 children along with their mothers. In this group, children benefited from working memory training and their mothers participated in parent training sessions. Parent and working memory trainings were conducted by a clinician with a Masters' degree and supervised by a PHD in child psychology. The participants of the three groups were concurrently under medication that was the same (Ritalin) for all the subjects. Also, the dosage of the medication was similar in all the participants according to their weight, so the three groups were homogeneous in this respect.

Instruments

To collect the required data, the present study employed the following instruments:

SNAP-IV

The SNAP-IV is a revision of the Swanson, Nolan and Pelham (SNAP) questionnaire (61). The items from the DSM-IV criteria for Attention Deficit Hyperactivity Disorder (ADHD) are included for the two following subsets of symptoms: inattention (items 1 to 9) and hyperactivity/impulsivity (items 10 to 18). SNAP-IV rating scale is a form eliciting teachers' and parents' responses. Scoring procedure is as follows: each item is scored on a Likert-scale type ranging 0-3 (never = 0, sometimes = 1, often = 2, always = 3). The total score is then divided by 18 and each subtype is divided by 9. To determine the cut-off point, the designers of the scale utilized mean and standard deviation of 1.65(61, 62). Sadralasadat et al. (1386) estimated the total cut-

off point and the cut-off point of the subtypes of ADHD-I and ADHD-H as 1.57, 1.1, and 1.9, respectively. (63)

The scale has acceptable validity and reliability indices. The total reliability of the scale and the reliability of the subscales calculated via Cronbach's alpha were found to be 0.97, 0.90, 0.76, respectively (62). In a similar vein, Sadroaldin et al., (1386) reported the reliability estimates of the scale calculated via test-retest, Cronbach's alpha and split-half reliability coefficients among a sample of Iranian children as 0.82, 0.90, and 0.76, respectively (63). This scale was utilized in the present study as a diagnostic test as well as pre-test and post-test to study the decline of the symptoms .

Child Behavior Checklist (CBCL)

Child behavior checklist (CBCL) which is appropriate for children within the age range of 6-18 years is completed by the parents according to the participant's condition over the preceding six months. CBCL comprises three sections: A) demographic information; B) competence and adaptive functioning criteria; C) DSM and experience-based scales. Each item is rated on a scale ranging from 0 (not true), to 1 (somehow true) and 2 (totally or often true). The total reliability of the instrument estimated via Cronbach's alpha was 0.97 and it was 0.94 via test-retest. The validity of the test is also satisfactory (64). Minaee's (1385) study demonstrated that Cronbach's alpha estimated for competence and adaptive functioning ranged from 0.65 to 0.91, Cronbach's alpha calculated for DSM was acceptable and ranged from 0.62 to 0.92. Cronbach's alpha computed for the subscales of ADHD in each form was found to be between 0.92 and 0.78. It is worth mentioning that CBCL was employed in the present study in order to diagnose the patients and examine the reduction of the symptoms of ADHD .

Clinical Interviews

Clinical interviews are the cornerstones for the diagnosis of ADHD. These interviews can vary by the objective, structure and source of data collection (66). In the present study, the diagnostic clinical interviews based on DSM-IV-TR criteria were conducted by a child and adolescent psychiatrist .

Working Memory Training Software

Working memory training software was designed by Khodadady, Mashhadi and Amani (1388); compatible with its English version made by the Cogmed Company, this software in a form of a computer game presents different tasks to improve the visual and auditory working memory (67).

Wechsler Intelligence Scale Fourth Edition (WISC-IV)

The current version, the WISC-IV, was produced in 2003. The WISC-IV is divided into fifteen subtests, ten of which formed a part of the previous WISC III. The five new subtests include three core tests: Picture Concepts, Letter-Number Sequencing, Matrix Reasoning and two supplemental tests: Cancellation and Word Reasoning. The WISC-IV generates a Full Scale IQ (FSIQ) which represents overall cognitive

ability. The four other composite scores are Verbal Comprehension index (VCI), Perceptual Reasoning Index (PRI), Processing Speed Index (PSI) and Working Memory Index (WMI). Some studies were conducted to examine the scale's reliability and validity in Iran. There was a significant correlation between WISC-IV, Raven's Progressive Matrices and WISC-II (68, 69).

Procedure

The present study was conducted in several phases. In the first phase, after the diagnosis was made by a child and adolescent psychiatrist, SNAP-IV rating scale and CBCL test were completed by the mother. In the second phase, the Wechsler Intelligence Scale for Children-Fourth Edition was implemented in order to homogenize the groups in terms of their IQs and to examine whether the participants had any intelligence incompetency. The third phase included the random assignment of the participants in the treatment groups and the onset of the treatment. After conducting the pre-tests, the training program derived from the Barkley's model was offered to the parent training group over eight private sessions. The training issues consisted of the following 10 steps:

Step 1: Introducing ADHD and presenting an overview

Step 2: Understanding parent-child relationship

Step 3: Improving positive attention skills

Step 4: Developing positive attention skills and enhancing child acceptance

Step 5: Creating a coupon-based economy at home

Step 6: Supplementing response cost

Step 7: Using timeout

Step 8: Managing children's behaviour in public places

Step 9: Making preparations for restraining school problems

Step 10: Back-up sessions

During the last session, SNAP-IV rating scale and CBCL test were completed again by mothers.

In the working memory training group, after performing pre-tests, children were required to take part in individual sessions. This procedure was reinforced through presenting strategies and feedback by the therapist. Besides, visual and auditory computer-based rewards encouraged the child to sustain his/her effort. At the end of the eighth training session, the post-tests were performed.

In the combined group, after completing the pre-tests, both trainings were concurrently presented for the mother and her child. Post-test was performed in the last session.

Before testing the research hypotheses, the WISC-IV intelligence test was conducted to ensure the homogeneity of the participants regarding their intelligence level. Data Analysis was done using SPSS version 18 and conducting MANCOVA test. $P < 0.05$ was considered significant.

Results

Due to gender differences prevalent in ADHD subjects, the frequency in each group favored boys. In addition,

the children of the parent training group had the lowest age average in comparison with their counterparts in the other groups. The highest frequency within the combined treatment group and working memory treatment group were related to the second grade primary school children; the highest frequency within the parent training group consisted of first grade primary school participants.

The results indicated that none of the participants had borderline intelligence or intellectual disability. The results of MANCOVA revealed no significant differences among the three groups regarding their verbal comprehension IQ, perceptual reasoning, processing time and total score (Wilks λ = 0.74, F= 0.95, P> 0.05). This plausibly demonstrates the homogeneity of the groups. In the current study, it was hypothesized that combined treatment in comparison with working memory training method, and parent training treatment per se are more effective in suppressing the ADHD symptoms. The following table shows the descriptive statistics of the three groups including means and P< 0.05, *** P< 0.001

standard deviations.

Table1. Means and standard deviations of the participants and the scores of the three groups on SNAP & CBCL

Table 1 indicates means and standard deviations of the participants' scores in combined treatment group, working memory training group and parent training group on SNAP and CBCL tests. MANCOVA was employed to test this hypothesis. The dependant variables in this analysis included the scores of attention deficit symptoms, hyperactivity/ impulsivity and the total symptoms of SNAP test as well as the scores of the inattention symptoms (experience-based scales) and ADHD clinical symptoms (DSM-based) contained in CBCL test. Pre-test scores were regarded as control variables and group represented the independent variable. Bartlett test was utilized to examine the correlation between dependant variables. The results indicated that the test is significant (χ^2 (14) = 229.38, p<0.001); this demonstrates a significant correlation among the dependant variables (68). The result of Leven's test of error variance homogeneity was not significant (p.0.05) which suggests that error variance was equal across all the levels of group variable.

Table2. MANCOVE results for comparing the performance of the three groups on SNAP & CBL

Table 2 reveals the results of MANCOVA among the three treatment groups. There was a significant difference among the groups in symptoms reduction (Wilks λ = 0.12, F48, 10 (= 9.09, P<0.05).

Table 1: Means and standard deviations of the participants 'scores of the three groups on SNAP and CBCL

Variable	WM		CT		PT		F	Eta Square
	SD	X	SD	X	SD	X		
SNAP								
Inattention Symptom	3.96	9.75	3.11	6.25	3.59	15.17	17.56	0.56
Hyperactivity/Impulsivity Symptom	3.55	12.58	3.28	6.67	5.19	12.25	10.48	0.43
Total Symptoms	7.11	22.33	2.11	12.92	7.95	26.42	13.78	0.5
CBCL								
Attention Problems Symptom (Experience-Based Scales)	2.80	8	1.53	5.83	2.48	10.83	10.39	0.42
ADHD Clinical Symptoms (DSM- Symptoms Based)	3.17	8.75	1.31	5.50	3.64	8.17	5.32	0.28

Table 2: MANCOVE results for comparing the performance of the three groups on SNAP and CBLC

Test	Value	Hypothesis df	Error df	F	Effect size
Pillai's trace	30.1	10	50	*29.9	65.0
Wilks' lambda	12.0	10	48	*09.9	65.0
Hotelling trace	86.3	10	46	*88.8	66.0
Roy's greatest root	39.2	5	25	*97.11	70.0

* P< 0.05

Table 3: the results of effect tests among the participants of the three groups on SNAP and CBLC

Variable	Sum of Source	Degrees of Freedom	Mean Square	F	Eta Square
SNAP					
Inattention Symptom	236/69	2	118/34	***17/56	0/56
Hyperactivity /Impulsivity Symptom	249/56	2	124/78	10/48***	0/43
Total Symptoms	794/75	2	397/38	13/78***	0/50
CBCL					
Attention Problems Symptoms (Experience-Based Scales)	111/60	2	55/80	10/39***	0/42
ADHD Clinical Symptoms (DSM- Based)	79/59	2	39/80	5/32*	0/28

Table 3. The results of effect tests among the participants of the three groups on SNAP & CBCL

As indicated in Table 3, the three groups displayed significant differences in the following variables: attention deficit symptoms ($F(2(8&2))= 17.56, P<0.001, 2\eta=0.56$), hyperactivity/impulsivity symptoms ($F(2(8 \& 2))= 10.48, P<0.001, 2\eta=0.43$), total symptoms ($F(2(8 \& 2))= 13.78, P<0.001, 2\eta=0.50$), attention problems (experience-based scales) ($F(2(8 \& 2))= 10.39, P<0.001, 2\eta=0.42$), and ADHD symptoms based on DSM ($F(2(8 \& 2))= 5.32, P<0.05, 2\eta=0.28$).

Comparative analysis of treatment groups employing multiple comparisons (LSD) suggested a significant difference between the combined treatment group and the two other groups in all the variables of SNAP and CBCL tests. The results indicated a significant difference between the combined treatment group and parent training group in suppressing the symptoms of attention deficit in SNAP test ($P<0.05$). A significant difference was also found between the combined treatment group and working memory training group ($P<0.001$). Furthermore, a significant difference was found ($P<0.001$) between the combined treatment group and working memory training group in the decline of total symptoms of SNAP test. Moreover, a significant difference ($P<0.05$) was observed between the combined treatment group and working memory training group in deficit (experience-based scales) of CBCL test. The difference in attention problems (experience-based scales) was also significant between the combined treatment group and parent treatment group ($P<0.001$). Moreover, a significant difference was detected between the combined treatment group and working memory training group ($P<0.01$) as well as between the combined treatment group and parent training group ($P<0.05$) in reducing clinical symptoms of ADHD (based on DMS).

Discussion

Various treatment methods for ADHD have been presented so far, among which working memory training as a psychosocial method has received substantial support (42, 46, 47, 51, 53). The effectiveness of parent training method has also been extensively confirmed in the literature. Plethora of research provides evidence that parent training as an evidence-based method is a well established treatment for children with ADHD (9). Although, research strongly supports the effectiveness of the combination of ADHD interventions (2, 9, 56, 57-59), the effectiveness of the combined methods of working memory training and parental training has not been investigated so far. Therefore, the objective of the present study was to examine the effectiveness of Barkley's parent training program, working memory training and the combination of these two interventions for children with ADHD.

The results of the present study demonstrated that combined treatment in comparison with the other two

methods suppressed the clinical symptoms of ADHD more significantly.

The findings of the current study are in accordance with previous researches. Hence, it can be concluded that the finding of the present study are consistent with that of other national and international studies, and we recommend combined method as an effective treatment for individuals with ADHD (56-59).

It is worth mentioning that the most significant reductions of hyperactivity/impulsivity symptoms, after combined treatment group, were observed in the group of parent training. This finding, in particular, indicates the positive impact of changes in parents' coping strategies with children's hyperactivity/impulsivity symptoms. This confirms the finding of previous research that supports parent training approaches in reducing ADHD symptoms of children (3, 9, 25-29).

In addition, the present research revealed that after the combined treatment group, the second most significant reduction of children's attention deficit symptoms occurred in working memory training group. Previous researches highlighted the effectiveness of working memory training and regarded this method superior to other psychosocial treatments (42, 46, 48-50, 52, 53).

The findings of this study, congruent with previous researches, indicate that parent training program is more effective in reducing the hyperactivity/impulsivity symptoms (2) and working memory training has a better effect on inattention symptoms of ADHD (46). Therefore, it seems safe to claim that combined treatment of working memory training and parental training has the best effectiveness on reducing both hyperactivity/impulsivity and inattention symptoms.

A combination of working memory training and parent training as a new approach within the domain of combined treatment methods of ADHD tends to not only impact the processes, functioning, and interactions between parents and children but also directly influences the children's memory functioning as one of the key modules of ADHD. Substantial research provides evidence for the effectiveness of combined interventions in helping children with ADHD (9, 55, 59). Moreover, combined method can be taken into account as a treatment approach in reducing symptoms and improving deficiencies associated with ADHD.

Limitations

In the present study, we had no long-term follow up. Small sample size was another limitation of this research.

Thus, further researches are required to encompass a larger sample of children with ADHD to differentiate various treatment methods in terms of their effectiveness and based on the sub-types of the disorder and they should also involve long-term follow ups.

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