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The Relationship between Working Memory Related Behaviors and Self-Regulation and the Symptoms of Attention Deficit Hyperactivity

Parvaneh Behrouzmanesh[1], Farnaz Keshavarzi Arshadi[2], Zohreh Sadat Moeeni[1]

[1]Master of Psychology and Education of Exceptional Childeren, Central Tehran Branch, Tehran, Iran.
[2]Assistant professor of Psychology, Psychology and Education of Exceptional Children, Islamic Azad University, Central Tehran Branch, Tehran, Iran.

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ABSTRACT

This study seeks to investigate the relationship between working memory related behaviors and self-regulation and the symptoms of attention deficit hyperactivity through a correlational method. The population consisted of primary school students studying in Tehran state schools in the school year 2012-13. Using multistage sampling method, a sample size of 180 students was selected from the students of the second grade, the third grade and the fourth grade (90 female and 90 male students). Then, measuring instruments including attention deficit questionnaire (19 items), hyperactivity (16 items), working memory (69 items), and self-regulation (85 items) were administered to them. The results of Pearson correlation showed that there was a significant relationship between working memory related behaviors and symptoms of attention deficit hyperactivity. Also, there was a significant relationship between self-regulation behavior and symptoms of attention deficit, hyperactivity and working memory. The results of stepwise multiple regression analysis showed that working memory and self-regulation-with 0.738 and 0.393 coefficients respectively- could predict attention deficit.

KEYWORDS: Attention deficit, Hyperactivity, Working memory, Self-regulation, Students.

1. INTRODUCTION

Attention deficit hyperactivity disorder is one of the most common developmental childhood disorders. The number of patients referred to medical centers for this disorder is larger than all other disorders. It is a neurological syndrome characterized by inattention, hyperactivity and impulsivity. Given its growing trend in recent decades, numerous studies have been conducted on this subject. Three to five percent of school age children suffer from this disorder and it is more common among male students. Attention deficit-hyperactivity disorder is a developmental pervasive disorder which is mainly characterized by inattention, impulsivity and hyperactivity [1]. The results of studies show that ADHD patients are deficient in a variety of areas including selective attention, activity attention and attention retention [2]. ADHD is a stable pattern of attention deficiency and impulsiveness which appear more frequently and intensely than that of normal children and is not in fitting with the development stage of individuals.

Some of the symptoms emerge before age 7 and cause clinically significant disorders in social, intellectual and professional functions of an individual which may last for more than 6 months. The prevalence rate of this disorder is between 3% and 7% with a ratio of 4 to 1 for boys and girls [3]. Recent studies show that children with attention deficit- hyperactivity have to deal with issues such as academic difficulties [4], social encounters [5] and superficial treatment [6]. These problems are severe and often persist until young adulthood [7]. Therefore, it is expected that self-educating and behavioral perception of students be negatively affected by attention deficiency hyperactivity disorder [8]. When the effect of inattention and restlessness on individuals is known, more efficient measures can be taken to deal with them. Scientists argue that the cause of distractibility and restlessness, which is examined in terms of attention deficiency and hyperactivity, is the deficiency of neurotransmitters that send messages from one cell to another. In patients with this disorder, the part of the brain that controls focus and attention is impaired. It should be noted, however, that this disorder does not affect the part of the brain that controls the intelligence of an individual. Distracted and restless children are often identical or even superior to other students in terms of intelligent quotient. Most patients with attention deficit hyperactivity disorder take medications as it helps them clam down and focus. Parents and pediatricians can make a schedule to set the consumption time and record the side effects of medications. When these patients take their medications, they may feel less hungry [9]. These medications are intended to reduce the negative effects of this disorder on children including attention-deficit disorder. The foundation of teaching and learning is attention and memory. Baddeley [10] highlights the fundamental role of memory in learning. Essentially, social (and school) learning is not possible without memory because learning is associated with the recording and storage of information. According to Baddeley [11], the role of memory in the human mind and behavior has not been overemphasized as only a handful of higher order nervous functions can operate successfully without the aid of memory. Perception, cognition, language, planning, problem solving and decision makings are all dependent on memory. One of the

***Corresponding Author**: Parvaneh Behrouzmanesh, Master of Psychology and Education of Exceptional Childeren, Central Tehran Branch, Tehran, Iran. E-mail: Parvaneh313@yahoo.com

pivotal functions of memory, which is particularly important in learning and teaching, is working memory. For the data to be effectively stored in memory, an individual must be actively involved in a task [10, 12]. Harter suggests that children with attention deficit hyperactivity disorder are more inclined to believe that they lack self-competency which may undermine their incentive for undertaking new and challenging task in the future. One way of improving children development is teaching behavioral self-regulation. The term behavioral self-regulation refers to implementing self-monitoring, self-evaluation and self-reinforcement. Self-monitoring is to maintain an active interest in particular purposeful thoughts and behaviors. It is related to the evaluation of the degree of active attention to denial event in specific purposeful behaviors. Self-evaluation is concerned with the judgment about the degree and quality of the behavior that varies relative to certain existing criteria or standards. Self-enforcement is specific measures adopted by individuals to strengthen their self. Overall, self-regulation is insufficient on its own and the intended improvements are largely unstable. Therefore, it needs to be integrated with self-reinforcement to bring about positive stable behavioral change. Studies show that self-regulatory methods can effectively improve the degree of focus on a task, academic achievement and social behavior in hyperactive children. In these methods, usually children participate actively in the process of evaluating their behavior [13]. Given the characteristics of children with deficient attention hyperactivity disorder, it can be concluded that the negative impacts of this disorder not only influence the cognitive functions of these children, but also the amalgamation of cognitive functions and behavioral reflections further compound this condition. Thus, although the direct evaluation of working memory is a critical cognitive function, it seems that the working memory related behaviors demand further attention.

The followings are examples of "working memory related behaviors," which are manifested as signs of abnormal behavior in these children:

It is difficult for them to follow their teacher's words. They keep daydreaming and fantasizing when they are doing a task. They have trouble beginning and terminating their works. They are not able to organize their work [12].

The hypotheses of this study are:

- Working memory related behaviors are associated with attention deficit symptoms.
- Working memory related behaviors are associated with hyperactivity symptoms.
- Working memory related behaviors are related to symptoms of attention deficit hyperactivity disorder.
- Self-regulatory behavior is related to symptoms of attention deficit hyperactivity disorder.
- Working memory related behaviors are associated with self-regulation.

Specific objectives of this study are as follow:

1) To study the relationship between working memory related behaviors and symptoms of attention deficit behavior;

2) To study the relationship between working memory related behaviors and symptoms of hyperactivity.

3) To study the relationship between working memory related behaviors with a combination of attention deficit and hyperactivity symptoms.

4) To study the relationship between working memory related behaviors and self-regulation

5) To study the relationship between self-regulation and attention deficits.

6) To study the relationship between self-regulation and hyperactivity.

7) To study the relationship between self-regulation and a combination of attention deficit and hyperactivity symptoms.

The present study attempts to provide deeper insights about the cognitive side effects of this disorder on behavior, which can lead to more accurate diagnosis and adoption of appropriate behavior modification techniques.

2. MATERIALS AND METHODS

Given the nature and objectives of the research, i.e., investigating the relationship between working memory related behaviors, self-regulation and symptoms of attention deficit and hyperactivity, a correlation method was adopted. The population of the study consisted of normal primary school students in Tehran in school year2012-13. For the study sample, normal students in the second grade, the third grade and the fourth grade that aged between 8 and 11 were selected. Random multi-stage clustering method was used for sampling. To collect data, first two districts of Tehran were chosen out of which two primary schools, one for girls and the other for boys, were selected for the study. Then, the sample population was chosen from the students of the above grades in these two schools.

The final sample consisted of 180 subjects, 90 boys and 90 girls, who were selected and studied as the sample group The research instrument was a 185-item questionnaire with questions about attention deficit hyperactivity disorder, working memory and self-regulation, which were derived from the following scales.

A) The Child Behavior Scale CBCL (Achenbach)

Achenbach's scale is a collection of forms designed for affordable and convenient measurement of competencies, actions or adaptive functions and emotional – behavioral problems. Using these forms, standard data can be achieved readily for a wide range of competencies, adaptive functions and emotional – behavioral

problems. Unlike many standardized tests, this questionnaire provides information about the strengths and weaknesses of children. The scale consists of three forms: Child Behavior Checklist (CBCL), Youth Self-Report (YSR) and Teacher's Report Form (TRF). They are parallel forms which allow systematic comparisons of different perspectives on the children. In this study, the CBCL form has been used. This form must be completed by parents, the person in charge of the children's custody or anyone who deals with children in a family-like environment and knows them completely. The respondent is required to answer a number of questions that measure the competencies of the child as well as some open-end questions about diseases and disabilities of the child. Moreover, it explores major concerns of the respondent about the child along with notable characteristics and qualities of the child. Finally, the respondent ranks the emotional, behavioral and social problems of the child. The questionnaire consists of 113 items, which are based on the condition of the child in the past 6 months, and are ranked as 0 = false, 1 = somewhat or sometimes true, 2 = very or often true. In the present study, 17 items out of 113 items of this questionnaire has been adopted. Achenbach [14] reported a reliability of 0.46-0.96 using Cronbach's alpha. He also obtained a validity of 0.52-0.88 through the correlation coefficient using CBRS and Quay and Peterson behavior problem checklist (Q-PRBPC) [15]. This test was validated by Siamak Samani for children of Shiraz Province in 1996 and a reliability coefficient of 0.59-0.8 was reported for subscales. Minaee [16] reported a range of internal consistency of 0.95-0.63 for scales, obtaining the temporal consistency of 0.32 to 0.67 for scales using the test-retest method in a 5-8 week interval. Yazdkhasti and Arizi [17] reported a Cronbach's alpha of 0.90, 0.93 and 0.82 for three forms of parents, teachers and children respectively.

B) Child Symptom InventoryCSI-4

Child Symptom Inventor (CSI-4) is a common screening tool for psychiatric disorders which is based on the criteria of the Diagnostic and Statistical Manual of Mental Disorder. The first version of the questionnaire was designed by Gadow and Sprafkin (SLUG) [18] in 1994 based on the categorization of the third version of Diagnostic and Statistical Manual of Mental Disorders, and then following revisions in the third edition of Diagnostic and Statistical Manual of Mental Disordersin 1987, CSI-3-R version was constructed. Finally, with the publication of the fourth edition of the Diagnostic and Statistical Manual of Mental Disorders in 1994 and by making a few changes in previous editions of Gadow and Sprafki's inventory [18], CSI-4 was presented. Similar to previous versions, CSI-4 has two checklists for parents and teachers. In the present study, the parent's checklist has been used. This checklist consists of 112 items out of which 18 items (group A) are related to attention deficit and hyperactivity disorders. Each item is answered on a four-point scale: 0 = never, 1 = sometimes, 2 = often and 3 = most times.

For deeper understanding of parents, symbolic forms (big and small circles) have also been used in the questionnaire. In the present study, Group A of the main questionnaire with 18 items on attention deficit hyperactivity disorder (including subgroups of attention deficit, hyperactivity, dominant and combined impulsivity) was adopted. The dominant attention deficit subgroup included items 1-9; the dominant impulsivity hyperactivity subgroup included items 10-18 and combined subgroup included item 1-18. CSI has already been examined in a number of studies and its validity, reliability, sensitivity and specificity have been calculated. Grayson and Carlson [19] in their study of CSI-3R reported a sensitivity of 0.77 for attention deficit hyperactivity disorder. Other studies reported a correlation of 0.72 between the CSI3R checklist and attention deficit hyperactivity disorder [18]. The content validity of CSI-4 was confirmed by nine psychiatrists in the study Mohammed Ismail [20] Tavakolizadeh et al. [21] reported a reliability of 0.90 for the parent's checklist using test-retest method. Najafi et al. [22] obtained an internal consistency of 0.92 using Cronbach's alpha coefficient.

C) Working memoryrelated behavior questionnaire

This form is derived from a series of questions compiled by Dehn [12] in a book about "working memory". Dehn [12] was the first to focus on the behavioral aspects of working memory and presented interviews methods and questionnaires to assess behavioral aspects of working in his book, which has been translated and adapted in this study. The questionnaire consists of 79 items on working memory behavior, 11 items on verbal working memory, and finally 9 items on executive working memory in multiple-choice format. To assess the internal consistency of this questionnaire, Cronbach's alpha was calculated for 50 subjects in the sample group, the results of which are presented in Table 1.

Table 1.

Working memory index	Cronbach's alpha coefficient
Class behavior	0.95
Verbal behavior	0.93
Executive	0.87
Total score of working memory	0.96

3. RESULTS

According to the Table 2, the results were only significant for the grade factor. To further explore these findings after observing the significant differences between the scores of working memory behaviors in different

grades, Tukey's post hoc test was used. The results suggested that the difference of the overall scores of working memory was significant between the second grade and the fourth grade.

According to Table 3, the results were significant only for the grade factor. These findings were consistent with the results of descriptive analysis, which were relatively predictable. Tukey's post hoc suggests that the difference of self-regulation behaviors cores between the second grade, the third grade and the fourth grade were significant.

As suggested by the findings of Table 4, the results were only significant for the grade factor. This finding, consistent with the results of descriptive analysis, is confirmed.

As shown in Table 5, the results were significant only for the grade factor. To further explore these findings after observing the significant differences between scores of hyperactivity in different grades, Tukey's post hoc-test was used. According to this test, the difference between scores of hyperactivity for the second grade, the third grade and the fourth grade was significant.

Table 1. Results of bivariate analysis of variance to compare total scores of working memory across gender and grade

Source of variation	Sum of squares	df	Mean squares	F	Sig.
gender	785.422	1	785.422	1.447	.231
Grade	7478.478	2	3739.239	6.890	.001
Grade-gender	80.344	2	40.172	.074	.929
error	94428.667	174	542.693		
Total	189278.000	180			

Table 2. Results of bivariate analysis of variance to compare self-regulation behavior score across gender and grade

Source of variation	Sum of squares	df	Mean squares	F	Sig.
gender	.272	1	.272	.006	.937
Grade	629.378	2	314.689		
Grade-gender	62.044	2	31.022	7.296	.001
error	7505.167	174	43.133	.719	.489
Total	16947.000	180			

Table 3. Results of bivariate analysis of variance to compare scores of attention deficit across gender and grade

Source of variation	Sum of squares	df	Mean squares	F	Sig.
gender	2.689	1	2.689	.132	.717
Grade	220.744	2	110.372	5.402	.005
Grade-gender	18.878	2	9.439	.462	.631
error	3555.267	174	20.433		
Total	7588.000	180			

Table 4. Results of bivariate analysis of variance to compare scores of hyperactivity across gender and grade

Source of variation	Sum of squares	df	Mean squares	F	Sig.
gender	2.689	1	2.689	.063	.803
Grade	379.144	2	189.572	4.422	.013
Grade-gender	27.144	2	13.572	.317	.729
error	7458.667	174	42.866		
Total	10976.000	180			

Table 5. Results of bivariate analysis of variance test to compare scores of attention-deficit - hyperactivity across genders and grade

Source of variation	Sum of squares	df	Mean squares	F	Sig.
gender	10.272	1	10.272	.056	.813
Grade	2242.878	2	1121.439	6.160	.003
Grade-gender	157.744	2	78.872	.433	.649
error	31679.433	174	182.066		
Total	68563.000	180			

Since the value of F was not significant after implementing Levan test, the condition of variance homogeneity was established for the analysis of variance test. As shown in Table 5, analysis of variance reveals that the results were only significant for the grade factor. The results of Tukey's post hoc test indicate that the difference of hyperactivity scores between the second grade, the third grade and the fourth grade was significant.

Table 6. Results of stepwise regression analysis of attention deficit in terms of predictor variables (components of working memory and self-regulation) in children

Statistical index / Variables	R	R^2	Standard error
Components of working memory behaviors	.738[a]	.544	3.11852
Self-regulation	.793[b]	.629	2.82059

According to the results of stepwise regression analysis of attention deficit in terms of predictor variables (components of working memory and self-regulation), the value of R2 indicates that the inclusion of predictor variables, i.e., working memory behaviors and self-regulation, explain 54% and 63% of attention deficit variations respectively.

Table 7. Results of stepwise regression analysis of hyperactivity in terms of predictor variables (components of working memory and self-regulation) in children

Statistical index / Variables	R	R^2	Standard error
Verbal behavior in working memory	.575[a]	.331	5.43961
Verbal behavior in working memory and self-regulation	.600[b]	.360	5.33555
Executive working memory	.613[c]	.376	5.28225

According to the results of stepwise regression analysis of hyperactivity in terms of predictor variables (components of working memory and self-regulation), the value of R2 indicates that the inclusion of all predictor variables, i.e., working memory behaviors and self-regulation, as well as executive working memory explain 54% and 63% of variations in hyperactivity respectively.

DISCUSSION

Attention deficit hyperactivity disorder in children causes a plethora of problems for children, their parents and teachers. The most obvious effects of this disorder are reflected in schools and educational matters. Although the emphasis has usually been on cognitive and educational problems of these children, the results of recent studies place more emphasis on the functions of working memory. The working memory loss tends to bring learning problems to mind, but some experts such as Dehn [12] have explored behavioral effects of working memory in everyday activities of these children, which seems to open new avenue of research in the field of attention deficit hyperactivity disorder. In this regard, this group of scientists believes that specific interviews should be made with the parents and teachers of these children. One aim of this study was to determine the degree of relationship and the share of working memory behaviors in each category of attention deficit and hyperactivity symptoms. The results of analysis confirm the research hypothesis about the existence of a significant relationship between working memory related behaviors and attentions deficit symptoms. Accordingly, H1 is consistent with the findings of Micco et al. [23], who found that children with ADHD disorder had impaired working memory and short term memory functioning. Moreover, Hameed and Nargesi [24] concluded that children with attention deficit hyperactivity disorder had significantly lower scores in the working memory and its subscales such as span of direct space, reverse space and number-letter sequence. The significant relationship between working memory behavior and symptoms of hyperactivity was also confirmed. This is consistent with the findings of Dehn [12] who found a relationship between the symptoms of hyperactivity and working memory, asserting that inattention to observations is indicative of deficits in working memory, particularly in the context of learning. He argues that the strong relationship between working memory and various fields of learning is a good indicator for the evaluation and detection of flaws in the working memory. The existence of a significant relationship between working memory related behaviors and symptoms of attention deficit and hyperactivity has been confirmed in previous studies. In addition, the bulk of research in this field has confirmed this hypothesis [23; 24, 12]. The results showed that self-regulation behavior is associated with attention deficit and hyperactivity. Garner [25] studied the relationship between attention deficit hyperactivity disorder and self-regulation, identifying four functions and executive operations that assist self-regulation including non-verbal working memory, verbal internalization, emotional self-regulation motivation, impulsiveness and reconstruction. They stated that (ADHD) disrupted these executive operations and influenced the control of behavior. In this line of research, Bakhshi et al. [26] studied the effectiveness of self-regulated strategy development on the writing performance of students with attention deficit hyperactivity disorder, concluding that self-regulated strategy reduced the spelling errors in these

students. Research findings confirmed the relationship between working memory related behaviors and self-regulation, which was consistent with the results of Schmeichel and Demaree [27]. This study offers a deeper insight into individual differences in terms of high working memory capacity (WMC), suggesting that high cognitive capacity can play a pivotal role in emotional and affective self-regulation.

Given the limitations pertained to the implementation of this study, the findings should be generalized with caution.

- Since this study was conducted for the students of Tehran, the results cannot be readily generalized to students in other parts of Iran.

- The questionnaires were completed by parents of participants and they may be bias towards their children's performance.

- Since the present study was carried out on primary students, the results cannot be generalized to other grades.

- The large number of items in the questionnaire may have bored parents and therefore influenced the results.

- Several demographic variables (e.g., age, income level, social class, etc.) may affect the performance of students, but given the difficulty of quantifying these variables, only the gender variable has been investigated in this study.

In general, the following recommendations are presented base on the findings of the study:

Since this study was conducted on primary students, researchers are recommended to study other grades in their future work as well. The population of the present study was limited to the students of Tehran, so other researchers can study the performance of students in other cities.

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