

Comparing Executive Function of Normal Children with ADHD Children

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Abstract

This study was conducted to compare with the executive function of ADHD versus normal male and female children. To obtain this objective, 30 ADHD children referring a private psychological center for the first time who had taken no medication for this disorder, and 30 normal children from one of the schools of District 14 in Tehran were selected randomly who were of the same age and gender of ADHD children. Wisconsin test was used as a measurement tool. Results showed that there is a significant difference between the average scores of the executive function of normal and ADHD children as well as average scores of the executive function of normal boys and ADHD children at the 0.01 level. In addition, there was a significant difference between the average scores of the executive function of normal girls and ADHD girls at the 0.05 level according to which null hypothesis is rejected. Therefore, ADHD children are of lower executive and cognitive function compared to normal children and have extensive cognitive deficits. Therefore, they require medications along with special training and rehabilitation.

Keywords: ADHD children, normal children, executive function, rehabilitation, cognitive deficits

1. Introduction

Today, paying attention to children and adolescent disorders is becoming increasingly important day by day. Meanwhile, mental disorders are of special status, since timely identification of these disorders reduces these children's dependence on others and prevents them from becoming chronic and being converted to other disorders in adulthood. One of these disorders is hyperactivity or attention deficit which has been considered a lot. Although this disorder has been explained for over a century, and it has been variously referred to over time. For instance, in 1890, William Jams have mentioned this disorder as "character" in a book under the title of *Principles of Psychology*. Then, in early 20th century, George Steal described hyperactive and impulsive children as those without volitional inhibition and moral control and investigated the effect of family factors and stated the possibility of brain injury in these children.

Healthcare professionals use the guidelines in the American Psychiatric Association's Diagnostic and Statistical Manual, Fifth edition (DSM-5), to help diagnose ADHD. This diagnostic standard helps ensure that people are appropriately diagnosed and treated for ADHD. Using the same standard across communities can also help determine how many children have ADHD, and how public health is impacted by this condition.

People with ADHD show a persistent pattern of inattention and/or hyperactivity-impulsivity that interferes with the functioning or development:

1) Inattention: six or more symptoms of inattention for children up to age 16, or five or more for adolescents 17 and older and adults; symptoms of inattention have been present for at least 6 months, and they are inappropriate for developmental level:

- Often fails to give close attention to details or makes careless mistakes in schoolwork, at work, or with other activities.
- Often has trouble holding attention on tasks or play activities.
- Often does not seem to listen when spoken to directly.

- Often does not follow through on instructions and fails to finish schoolwork, chores, or duties in the workplace (e.g., loses focus, side-tracked).
- Often has trouble organizing tasks and activities.
- Often avoids, dislikes, or is reluctant to do tasks that require mental effort over a long period of time (such as schoolwork or homework).
- Often loses things necessary for tasks and activities (e.g., school materials, pencils, books, tools, wallets, keys, paperwork, eyeglasses, mobile telephones).
- Is often easily distracted.
- Is often forgetful in daily activities.

2) Hyperactivity and Impulsivity: six or more symptoms of hyperactivity-impulsivity for children up to age 16, or five or more for adolescents 17 and older and adults; symptoms of hyperactivity-impulsivity have been present for at least 6 months to an extent that is disruptive and inappropriate for the person's developmental level:

- Often fidgets with or taps hands or feet, or squirms in seat.
- Often leaves seat in situations when remaining seated is expected.
- Often runs about or climbs in situations where it is not appropriate (adolescents or adults may be limited to feeling restless).
- Often unable to play or take part in leisure activities quietly.
- Is often "on the go" acting as if "driven by a motor".
- Often talks excessively.
- Often blurts out an answer before a question has been completed.
- Often has trouble waiting his/her turn.
- Often interrupts or intrudes on others (Diagnostic and Statistical Manual of Mental Disorders, 2013).

Children with attention deficit-hyperactivity disorder are characterized by hyperactivity, impulsivity and lack of attention. In terms of cognitive deficits of this disorder, significant studies have been conducted on fields paid heed to in these studies is a deficiency in executive function and of studies conducted in this area, studies by Hilton et al. (2005) can be mentioned who showed that the ADHD children demonstrated weak performance in identifying colors, shapes and numbers in Wisconsin test. In studies conducted in Berkeley Hospital, Stovart and Fronchi (2006) demonstrated that ADHD children are of weak mental performance in terms of executive function and mental flexibility. Sagvolden et al. (2005) stated that this disorder is the result of dopamine hyperactivity of the limbic system. Research on patients with ADHD, who have a problem in ventromedial frontal part, showed that they consciously tendency to evaluations more negative of unmorally behaviors, But when the action is morally good; this evaluation does not take place (Alexandru et al., 2011).

In addition to all these cases, in some studies damages included sections related to designing, extension, retention and regular cognitive processes. Considering all these studies, the author's hypothesis is that there is a significant difference between the executive function of normal and ADHD children. In addition, it is supposed that this difference is also observed in terms of gender. With regard to these cases, it appears that the results of this study can assist teachers and educators in schools in understanding these children and predicting their behavior in various situations. In addition, psychologists can employ results of this study in planning appropriate treatment plans for these children and their families and finally it raises understanding of ADHD children's associates and result in their more cooperation in line with more effective treatment. Furthermore, timely diagnosis can reduce behavioral problems, school problems and collateral damages, including social and cultural damages to these children. According to these cases, the author plans to answer this question whether there is a difference between the executive function of normal and ADHD children and whether this difference is the same in both genders.

2. Methodology

This was a causative-comparative, post-event study. The statistical population included all normal and ADHD children between 7 and 11 years of age in Tehran. To obtain samples of ADHD children, 30 ADHD subjects were selected from all children between 7 and 11 years of age, referring private psychological centers for the first time and diagnosed with ADHD based on DSM-IV-TR classification using accessible sampling and they were interviewed and examined and had no medication history until this study was conducted. This sample

included 7 girls and 23 boys. In addition, to obtain a sample of normal children, multi-stage random sampling was used. First, a girl's school and a boy's school were selected in one of the districts of Tehran (District 14) and 30 children between 7 and 11 years of age with no psychological disorder were investigated. It is noteworthy that normal children were matched in terms of age and gender variables with ADHD children.

2.1 Data Collection Tools

Wisconsin Card Sorting Test (WCST) was used as the tool and it was first provided with the attempts of Grant and Berg in 1948 and it is being used extensively to study abstract behaviors and assess problem-solving and decision-making skills. It was planned to diagnose and treat attention deficit and hyperactivity in children and adolescents (John, 2016). It consists of 64 dissimilar cards on which four shapes are each printed with a different color. Therefore, the subject is tested based on three principles of shapes, numbers, and color. In fact, each card shows a state that is not repeated. In this test, the child should maintain the concept of rule understood in a stage of testing and they should change previous concepts as sorting rules change. If the subject continues sorting based on previous model or sorts cards based on false speculation despite changes principle by the tester, it means they have made preservation error that includes repeating a pre-learned answer for a new stimulus which is one of the main indices of frontal lobe damage. Other errors in assessing answers include problems in displacement, flexibility, attention deficit, absent-mindedness, memorizing, purposeful activities, color, shape and number pattern and continuity of card sorting. To conduct this test, the subject should place cards based on the principle that presents the pattern of tester's answers. Their performance determines their score and then they go to the next stage. Here, the executive function includes set-shifting, set-maintenance, interference control, inhibition, integration of time and place, planning and working memory (Tehrani et al., 2004) and this function is a score obtained from subjects in Wisconsin test.

After collecting primary data and conducting the test, independent t-test was used to determine whether variables are different significantly and data were analyzed using SPSS 11 software.

3. Results

As a process of a scientific method, a section of results is one of the cornerstones of any research method and includes a method through which the whole process of study is directed, from choosing a problem in obtaining a result. Therefore, in this study the following results were obtained from independent t-test after recording raw scores from test conducted:

Table 1. Comparison of executive function in normal and ADHD children

Comparison	N	Mean	Standard deviation	Degree of freedom	t	P-value
Executive function of normal children	30	9.97	2.79	58	7.24	0.01
Executive function of ADHD children	30	3.83	3.71			

In each section, to use the t-test for two independent groups, the first assumption of a similar variance in both groups was confirmed and to this purpose, calculated F was compared with tabulated F. Because of being smaller, condition for equality of variances is observed in all following comparisons.

Based on a comparison of the average scores of executive function in normal and ADHD children, it can be concluded that since calculated t (7.24) is bigger than tabulated t with df=58 (2.704), the null hypothesis is rejected and we conclude with 99% confidence that there is a significant difference between the average scores of brain executive function in normal and ADHD children obtained from Wisconsin test. Therefore, it is concluded that brain executive function of normal children is in fact higher compared to ADHD children.

Table 2. Comparing executive function of normal and ADHD boys

Comparison groups	N	Mean	Standard deviation	Degree of freedom	t	P-value
Executive function of normal children	23	9.87	2.75	44	6.68	0.01
Executive function of ADHD children	23	3.57	3.59			

8) In comparing executive function of normal and ADHD boys, since calculated t (6.68) is bigger than tabulated t with $df=44$ (2.704), the null hypothesis is rejected and with 99% confidence, we conclude that there is a significant difference between the executive function of normal and ADHD boys obtained from Wisconsin test. This finding shows that normal boys have a relatively higher executive function compared to ADHD boys.

Table 3. Comparing executive performance of normal and ADHD girls

Comparison groups	N	Mean	Standard deviation	Degree of freedom	t	P-value
Executive function of normal girls	7	10.29	3.15	12	2.79	0.05
Executive function of ADHD girls	7	4.71	4.23			

According to data obtained from comparative brain executive function of normal and ADHD girls, again since calculated at 2.79 is bigger than tabulated it with $df=12$ (2.021), the null hypothesis is rejected and with 95% confidence, it is concluded that there is a significant difference between the average scores of executive function in normal and ADHD girls obtained from Wisconsin test. This finding suggests that brain executive function of normal girls is better compared to ADHD girls. It should be noted that difference in executive function of normal and ADHD group is less in girls compared to boys.

4. Discussion and Conclusion

From results of this study, it can be inferred that since Wisconsin is a Neuro-psychological test that examines brain excellent functions, ADHD children are of lower executive and cognitive function compared to normal children in this test and they make more mistakes in reacting to stimuli and perform slower in such a way that even in color, the shape and number pattern of Wisconsin test, a significant difference is observed between normal and ADHD children. These results suggest that ADHD children have problems with displacing intended patterns of cards (color, shape and number) and they are slow in learning the order of rules and patterns of Wisconsin cards. Lower Wisconsin scores of ADHD children compared to normal ones suggest a deficit in executive function of ADHD children and this result complies with results and findings of Veit et al. (2007), Jennifer et al. (2007), Stovart and Fronchi (2006), Yasper and Anjelo (2005), Hilton et al. (2005), Hartman and Grep (2004) and Durkin et al. (2004). This result can be stated that malfunction of the frontal lobe, the especially limbic system the main task of which is executive function suffers from disorder and affects results of Wisconsin test. In addition, imaging studies conducted in children and adolescents with hyperactivity disorder has continually pointed to a significant decrease in brain activity in inferior frontal cortex areas in the anterior cingulate gyrus (Fiorello et al., 2009).

In addition, ADHD children have the following problems and most of these results comply with the results of Durkin et al. (2004) and Kaplan and Sadock (2003):

- 1) In terms of preservation error, ADHD children are not different from normal children and this result does not comply with the results of other studies.
- 2) In terms of displacement of test cards, ADHD children have a problem and this result complies with results of Pitterman et al. (2005). Probably, these children cannot displace intended patterns in the cards by tester because of having a problem in learning cards order and rules.
- 3) In terms of flexibility, ADHD children have a problem with this test and this result complies with results of Stovart and Fronchi (2006) and Pitterman et al. (2004). This problem may have occurred as a result of information processing which is one of the executive functions.
- 4) In terms of attention deficit, ADHD children suffer from depletion and this finding complies with results of Weiner et al. (2003), Lewis (2003) and Kronenberger and Meyer (1996). This problem can be explained in such a way that probably ADHD children suffer from attention deficit because of the disorder in the performance of the limbic system, especially basal ganglia that play the important role in controlling stress and external information and data.
- 5) In terms of distraction, ADHD children suffer from it and this finding complies with results of Durkin (2004), Weiner (2003), Kaplan and Sadock (2003).

6) In terms of learning and memorizing, ADHD children have problems and this finding complies with the findings of Kaplan and Sadock and this problem is the result of attention deficit, distraction, and hyperactivity in these children.

7) In terms of purposeful activities, ADHD children are disabled and this result complies with the findings of Durkin et al. (2004), Weiner (2003) and Graham et al. (1999). This problem is also the result of attention deficit, distraction, and hyperactivity in these children. One of the reasons of these children not being motivated to do their homework and purposeful activities can be the result of frequent failures in previous attempts (Lewis, 2003).

8) Pattern of colors, shapes and numbers are another part of this test and in this study ADHD children had problems and this result complies with results of Hilton et al. (2005), Durkin (2004) and Hartman and Gerp (2004). It is the result of preservation and a problem with displacing cards.

9) Error in sorting continuity of cards is the last problem of ADHD children in this study that complies with results of Jennifer (2007).

10) In general, considering above findings, it can be concluded that these children suffer from extended cognitive deficits and deficit in executive function. Therefore, they require training and special rehabilitations along with medication.

In terms of using this test for diagnosis, it should be said that most parents ask for a psychological diagnostic test for their children who probably suffered from ADHD. However, there is no special psychological test that can be used in diagnosing ADHD as a replace for clinical evaluation and interview with children and their families (Lewis, 2003). However, today, part of development resulted from diagnosis and treatment of ADHD is related to applying common psychological scales, i.e., Wisconsin test that is obviously a complex diagnostic process based on the clinical judgment which is mostly conducted based on identifying DSM-IV-TR criteria (Kaplan & Sadock, 2005). It is worth that in later studies more tools including LNNB-I as other pathology tests, including CT-scan and MRI to be used and along with using a bigger sample other demographic variables to be considered including intelligent quotient, habitat, an economic and social status of parent, etc.

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