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The Comparison of Divided, Sustained and Selective Attention in Children with Attention Deficit Hyperactivity Disorder, Children with Specific Learning Disorder and Normal Children

Fatemeh Maghsoodloonejad,[1] and Hadi Hashemi Razini[2,*]

[1]Department of Clinical Psychology, College of Human Science, Saveh Branch, Islamic Azad University, Saveh, IR Iran
[2]Assistant Professor, Department of General Psychology, Faculty of Psychology and Education, Kharazmi University, Tehran, IR Iran

[*]*Corresponding author*: Hadi Hashemi Razini, Assistant Professor, Department of General Psychology, Faculty of Psychology and Education, Kharazmi University, Tehran, IR Iran. E-mail: hhashemmi.ra@gmail.com

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Abstract

Background: High incidence of learning disorders has caught the psychologists' attention in recent years.
Objectives: The objective of this study was to compare divided, sustained and selective attention in children with attention deficit hyperactivity disorder, children with a specific learning disorder and normal children.
Methods: The study was a descriptive, causal-comparative and fundamental research. The population consisted of all children with attention deficit hyperactivity disorder (ADHD) and children with specific learning psychology (SLD), aged 7 to 12 years old, who referred to counseling and psychiatric clinics in Tehran in 2016, as well as normal primary school children. 36 children with attention deficit hyperactivity disorder and 47 children with specific learning difficulties were selected through convenience sampling, and 43 ordinary primary school children with cluster-randomly sampling method. Continuous performance test, word color Stroop test and the Wechsler scales were used as the instruments of the study. Descriptive and inferential statistics along with multivariate analysis of variance in Spss-21were used to analyze data.
Results: The results of this study showed that weakness in divided, selective and sustained attention in children with attention deficit hyperactivity disorder and children with specific learning disorder is more than normal children ($P < 0.05$). However, there was no significant difference between these variables in children with attention deficit hyperactivity disorder and children with specific learning disorder ($P < 0.01$).
Conclusions: The results showed that the rate of comorbidity was very high in children with attention deficit - hyperactivity disorder and children with specific learning disorder.

Keywords: Attention, Children, Attention Deficit Hyperactivity Disorder, Specific Learning Disorder

1. Background

Attention deficit hyperactivity disorder (ADHD) and specific learning disorder (SLD) have a common feature in terms of attention deficit (1). ADHD is distinct from other disorders since ADHD has been the most widely studied mental disorder in children and it is a controversial subject. ADHD is a neurobehavioral developmental syndrome rooted in childhood. This syndrome includes attention deficit, hyperactivity and impulsivity that are inappropriate to the development level of an individual (2). The first issue that is used in this definition for describing ADHD is neurobehavioral developmental disorder. Neuro behavioral developmental disorders are those that occur during development period and usually appear before elementary school and are determined by personal, social, academic or occupational problems resulted from developmental deficit (1).On the other hand, according to the Psychiatric Association of America (1), specific learning disorders (SLD) are recognized as one of the neuro developmental disorders. Disorders are often detected when there are some deficiencies in receiving and processing the information (Auditory memory, auditory perception, auditory sequencing, visual memory, visual perception, and visual sequence) efficiently and correctly.

Attention subject is one of the most important and complex effective factors of teaching and learning. In other words, one of the most frequent problems among children which reduce efficiency at school is lack of attention. Attention is told to be a series of complex mental activities including focus on purpose, keeping or endurance

and being alert in a long time, encoding the simulative properties and shifting focus from one purpose to another (3).

Mathematics learning disabilities may be associated with difficulties in attention. There is a mental disability that most children suffering from learning disabilities are faced with. It is inability in focus, precision and attention on discussed topic, and natural growth process of children with learning disabilities is delayed or interrupted in gaining precision and natural attention (4). Because of attention deficit in SLD and great importance of attention to deficit for diagnosis of ADHD, children's studies often focuse on four areas of attention among different models of attention (5, 6). Orienting/ alertness attention (The ability of increasing individual's activity level from fine actuator to higher priorities) (7), Selective/ focused attention (ability of facilitating processing of an environmental information source during reducing of other processing) (7), Divided attention (ability of attention and response to several subjects, or several demands at once) (8), vigilance/ sustained attention (Ability of maintaining a potentially position of alertness in long period and stability of mental activity) (9).

Many children around the world with symptoms of attention deficit refer to psychologist or psychiatrist every year. Undisputed results of attention deficit are learning disorders that children are grappling with it. Drug therapy is the first line of treatment of attention disorders but medication can't alone satisfy the needs of children. According to that, there are different definitions for attention, it is necessary to discussed one of the new theories in this field to understand better the brain networks involved in this matter. The model that we propose here was presented by "Pasntor and Reuben" in 2007 (6). In this model, attention control is done by network which has three subcategories. The first section in this subsystem network is alerting. The parts related to this sub-system in brain allowing the person to remain in consciousness state and response to the symptoms that are indicative of a future happening. Those parts of the brain that are related to subsystem include parietal cortex, right frontal cortex, and locus cerulean that all are associated with norepinephrine neurotransmitter. The second part of the attention control network is orienting. In fact, this subsystem puts attention sources in the path of sending sensory information and among the sensory information that selects what it wants (6).

The third and last part in the attention control network is executive attention system. This part organizes behavior of the person in response and attention to stimuli in relation to your goals and desires. Among the duties of this part is identifying and resolving contradictions. Dopamine is a neurotransmitter associated with this subsystem. It is assumed that the brain's default network deals with internal states and our thoughts. According to that, different kinds of attention can have somehow deficit in children with ADHD and also according to that, one of the related characteristics of children with SLD may be various kinds of attention deficit that have caused their problems and on the other hand, it is seen less in normal children. The main issue of this study with respect to the vacuum of research in this area and the lack of similar researches in the country is that, are there any differences in divided, sustained and selective attention in children with ADHD, children with SLD and normal children?

Objectives: The objective of this study was to compare divided, selective and sustained attention in children with attention deficit hyperactivity disorder, children with specific learning disorder and normal children.

2. Methods

The study was a descriptive, causal-comparative, quantitative and fundamental research.

Target statistical population of this study was all children with ADHD and children with SLD and normal children. The available statistical population consisted of all children with ADHD and children with SLD, aged between 7-12 years, who referred to Tehran psychology and counseling centers and psychiatric clinics in 2016. Furthermore, all children in normal primary school in 2016 were included in the study. 36 children with ADHD and 47 children with SLD were selected through convenience sampling method. 43 children in normal primary school were selected by cluster random sampling for current research sample. However, according to the experts' opinion (10) selecting a sample of 100 people is suitable for causal-comparative researches. But in this study, considering that 15 to 20 percent of the questionnaires and participants are decrease, the total sample size in this study was 126 persons.

Inclusion criteria for participants of the study included: having original diagnosis of ADHD, having original diagnosis of SLD (reading / writing or calculating), and the age ranged between 7 and 12 years. Exclusion criteria for the participants of the study included: any other significant disorders (such as conduct disorder, behavior, etc.), obvious physical diseases (such as epilepsy, cerebral palsy); other comorbid disorders such as borderline intelligence that learning disorders is secondary than it.

In this study, the following instruments were used:

1- Continuous performance test (CPT): this test is used to assess sustained attention. This computer software is superior because of its objectivity and psychologist will see a

child's performance in the obtained results of the test and detect his disorder. Continuous performance test provides objective and reliable measurement of attention and impulsivity reduction with measurement of committing error, omission errors, and reaction time. This test includes visual stimuli (numbers and shapes) and its conducting takes between 14 to 20 minutes. The obtained results of this test can be examined in three areas of correct answer, removed answer and wrong answer. The validity of this test was confirmed by psychologists and psychiatrists. The reliability of this test was reported in a range between 0.80 and 0.91 (11).

2- Word color stroop test: this test is used to measure selective attention. Also it is used in different studies in multiple clinical groups in order to measure ability of response inhibition, selective attention, cognitive variability and cognitive flexibility (11). In fact, Stroop test is not an only test but various forms have been prepared for research purposes. The purpose is that the participants use maximum ability and achieves best performance fast. Computer measures reaction time of person in response to every word as well as the number of correct and incorrect response exactly. For scoring and interpretation of the achieved results of this test, scores are calculated separately for congruent and incongruent stimuli groups: Test time, number of errors, number of unanswered; correct number, time of reaction and interference score. Interference score was calculated in this test by calculating the difference between numbers of correct words and correct number of congruent and incongruent words. (Interference score = score of correct number of congruent words - score of correct number of incongruent words). The conducted research on this test indicates suitable reliability and validity in measurement of inhibition in adults and children (11). Test-retest reliability of this test was reported between a range of 0.80 to 0.91 (11).

3- Number-word sequence (Wechsler 4): this test is used to measure divided attention. Fourth Wechsler intelligence scale for children is one of the most common and reliable clinical research tools to measure children's intelligence. Five IQ is inferred from fourth edition of children Wechsler: verbal comprehension IQ, perceptual reasoning IQ, working memory IQ, processing speed IQ and full IQ (12). The mean of this test was 100 and its standard deviation was 15 and 2 standard deviations below the mean were considered mentally retarded (12). Number-word sequence subtest is very important for diagnosis of divided attention deficit if he/she can't tell the sequence is the sign of divided attention deficit. We record clinical information (such as tick, careless, disquiet, etc.). This subtest measures attention, sequencing, information recording, simultaneous processing, phonological awareness, short-term memory, and visual-spatial imagery, also it measures capacity and short-term working memory. Test-retest reliability of this subtest has been reported as 0.72 in Iran. The validity of Wechsler 4 was obtained by correlation between Wechsler 4 and Raven's progressive matrixes test. It is reported as 0.65 (12).

After selecting the participants as expressed above, comprehensive assessment was achieved in a few days using mentioned tests and parental consent. Finally, after assessment of all 126 persons, data entered into SPSS-21 software and research's hypothesizes were examined. Statistical analysis is done in two parts of descriptive and inferential. The descriptive statistics included mean, standard deviation and in inferential part, the two groups were compared with respect to the assumptions and using multivariate analysis of variance (MANOVA) test and one-way analysis of variance (ANOVA).

3. Results

In this part, analysis of data was done in two main sections. In the first part, findings of the collected data will be described and presented and then in second part, calculations of inferential statistic and results of the tests will be discussed.

The means and standard deviations of variables are provided in form of frequency tables (Table 1).

The results showed that the normal group has achieved higher mean in number-word sequence test than the two clinical groups. In terms of the number of errors and total score, normal group achieved lower continuous performance test.

In the following, divided, sustained and selective attention (dependent variables) was compared in three groups of children with ADHD, children with SLD and normal children using MANOVA and ANOVA.

The first question explains: is there any difference in children with ADHD, children with SLD and normal children in terms of divided attention?

As can be seen in Table 2, significance level of F test is lower than the determined alpha level ($\alpha = 0.05 =$) indicating that there is a significant difference between groups in divided attention. The results of ANOVA and Tukey test are presented in Table 3 to examine exact location of difference.

Achieved results in Table 3 shows significant difference in children with ADHD, children with SLD and normal children. However, there isn't any significant difference between children with ADHD and children with SLD.

The second question explains: is there any difference in children with ADHD, children with SLD and normal children in terms of sustained attention?

Table 1. Mean and SD of Groups' Performance in Wechsler Memory Scale, CPT and Stroop Test

Test	Variable	Normal	ADHD	LD
Wechsler memory	Divided Attention	9.58 ± 3.12	7.27 ± 3.69	7.78 ± 2
Continuous performance	Correct answer	145 ± 4.9	137.73 ± 8.1	121.31 ± 12.8
	Deleting answer	3.39 ± 3.7	7.82 ± 5.1	15.73 ± 5.5
	Incorrect answer	2.83 ± 1.97	4.64 ± 3.21	13.42 ± 7.23
Stroop	Inference time	29.50 ± 48.08	26.95 ± 59.79	39.17 ± 65.18
	Inference score	0.88 ± 2.48	2.86 ± 5.11	4.22 ± 4.79

Table 2. ANOVA Significant Test on Main Effect of Groups' Variable in Divided Attention

	Divided Attention				
	Sum of Square	**D**	**Mean of Squares**	**F**	**Sig.**
Between group	312.27	156.13	2		
Within group	5987.29	48.67	123	3.20	0.021
Total	399.56		125		

Table 3. Result of Tukey Post-Hoc Test of Three Groups' Scores in Divided Attention Performance

Variable	df	MS	F	Sig	Reference Group	Compared Group	Mean Difference	Standard Error	Sig.
				0.021	Normal	ADHD	1.53	0.429	0.021
						SLD	2.58	0.454	0.002
Divided attention	2	37.42	4.17		ADHD	Normal	-1.53	0.429	0.021
						SLD	-0.38	0.471	0.329
					SLD	Normal	2.58	0.454	0.002
						ADHD	-0.38	0.471	0.329

As can be seen in Table 4, significance level of biggest root test is lower than the determined alpha level (α = 0.05), so allowing the usability of multivariate analysis of variance. This indicated that there is a significant difference between groups in subscales of continues performance to measure sustained attention. The results of multivariate analysis of variance and Tukey test were presented in Table 5 to examine the exact location of difference.

The achieved results in Table 5 shows the significant difference in children with ADHD, children with SLD and normal children but there isn't any significant difference between children with ADHD and children with SLD.

The third question explains: is there any difference in children with ADHD, children with SLD and normal children in terms of selective attention?

As can be seen in Table 6, significance level of biggest root test is lower than the determined alpha level (α = 0.05), so allowing the usability of multivariate analysis of variance. This indicated that there is a significant difference between groups in subscales of Stroop test to measure selective attention. But this difference does not specify which groups have difference in which variables. The results of multivariate analysis of variance and Tukey test were presented in Table 7 to examine paired groups.

Results of Table 7 shows that the studied groups do not have a significant difference in terms of interfere time. Because significance level in the groups paired examination was higher than the determined alpha level ($\alpha = 0.05$). But in terms of inference score, there is a significant difference between normal children and children with ADHD (Sig = 0.030, $\alpha < 0.05$). There isn't significant difference between two groups of children with specific learning disorder and children with attention deficit hyperactivity. Also, there are no significant differences between normal children and children ADHD in terms of interference score.

4. Discussion and Conclusion

This study was conducted to compare the divided, sustained and selective attention in children with ADHD, children with SLD and normal children. The results showed

Table 4. Multivariate Analysis of Variance Significant Test on Main Effect of Groups' Variable in Sustained Attention

Variable	Test	Value Statistics	F	Hypothesis df	df Error	Sig.
Group	Asrpylayy	0.254	3. 746	10	120	0.018
	Wilks Lambda	0.754	3.758	10	118	0.011
	Hotelling effect	0.314	3.822	10	116	0.014
	Larger of root	0.272	5.270	5	60	0.011

Table 5. Result of Multivariate Analysis of Variance and Tukey Post-Hoc Test of Three Groups' Scores in Continuous Performance

Variable	df	MS	F	Sig.	Referenced Group	Compared Group	Mean Difference	Std. Error	Sig.
Correct answer	2	19371.7	3.466	0.01	Normal	ADHD	-15.42	60.389	0.02
						LD	45.31	63.920	0.01
					ADHD	Normal	15.42	60.389	0.02
						LD	60.73	66.255	0.01
					LD	Normal	-45.31	63.920	0.01
						ADHD	-60.73	66.255	0.22
					Normal	ADHD	10.91	29.036	0.01
						LD	6.34	30.734	0.02
Removed answer	2	721.30	4.172	0.01	ADHD	Normal	-10.91	29.036	0.01
						LD	-4.57	31.856	0.35
					LD	Normal	-6.34	30.734	0.02
						ADHD	4/57	31.856	0.035
Incorrect answer					Normal	ADHD	-8.02*	3.028	0.01
						LD	-6.12	3.205	0.02
		422.5	3.868	0.02	ADHD	Normal	-8.02*	3.028	0.027
	2					LD	1.91	3.322	0.32
					LD	Normal	6.12	3.205	0.025
						ADHD	-1.91	3.322	0.32

Table 6. Multivariate Analysis of Variance Significant Test on Main Effect of Groups' Variable in Selective Attention

Variable	Test	Value Statistics	F	df	df Error	Sig.
Group	Asrpylayy	0.107	1.77	10	120	0.138
	Wilks Lambda	0.894	1.79	10	118	0.135
	Hotelling effect	0.118	1.80	10	116	0.132
	larger of root	0.113	3.57	5	60	0.034

a difference between children with ADHD, children with SLD and normal children in terms of divided attention ($P < 0.05$); but there wasn't any difference between children with ADHD and children with SLD ($P < 0.01$).

This result is consonant with research conducted recently in (2016) that in their study it was emphasized that children with ADHD have poorer performance than normal children in divided attention and memory. In explanation of this finding, it can be said that attention is one of the most important cognitive processes that is underlie of thinking and learning (13). On the other hand, children with ADHD are easily distracted and their attention is transferred to other stimuli in the environment. Since attention is basis of the memory, distraction leads to lack of maintenance and storage and categories of memory are not formed (14). This matter also is explainable from neuroscience perspective. According to this perspective, attention and working memory functions involve common areas in brain (15).

Another finding of the present study was the difference in the examined groups in sustained attention. According to the obtained results, children with ADHD showed poorer ability than normal group in terms of continuous attention on a task. This result is aligned with a study

Table 7. Result of Multivariate Analysis of Variance and Tukey Post-Hoc Test of Three Groups' Scores in Stroop Test[a]

Variable	df	MS	F	Sig	Referenced Group	Compared Group	Mean Difference	Standard Error	Sig
Interference score	2	62.004	3.56	0.034	Normal	ADHD	-1.98	1.207	0.237
						LD	-3.34	1.278	0.030
					ADHD	Normal	1.98	1.207	0.237
						LD	-1.36	1.325	0.564
					LD	Normal	3.34	16.245	0.030
						ADHD	3.34	1.325	0.564
Interference score					Normal	ADHD	2.55	16.245	0.987
						LD	-9.67	17.195	0.841
	2	806.788	0.27	0.775	ADHD	Normal	-2.55	16.245	0.987
						LD	-12.21	17.823	0.733
					LD	Normal	9.67	17.195	0.841
						ADHD	12.21	17.823	0.733

[a] *P < 0.05 and **P < 0.01.

in (2017) confirming that children with attention deficit-hyperactivity have deficit in attention function (16). In addition, Bigura et al. (2016) showed that deficit in some executive functions such as attention may be associated with poor performance in school of the group of children (13).

Aligned with this result, Mazzocco and Hanich (2010) showed in their study that children with math learning disability are significantly different from normal children in terms of executive performance, that one of the most important is ability of paying attention (17). Researchers showed that students with mathematics disorder are weak in comparison to normal students in planning action. Students with learning difficulties and attention deficit have often difficulties in sorting, organizing and prioritizing of information and when they are trying to identify main issues, focus more on details. As a result, they may be confused by accumulation of information because they can't easily start new assignments nor do flexible change among alternative strategies.

In third question of research, selective attention of children with ADHD, children with SLD and normal children were compared. Aligned with results of this study, Wong et al. (2015) showed in the study that children with math learning disorder in comparison with healthy children have significant inhibition (18). Also other study showed significant difference between children with mathematics learning disorder and normal children in inhibition (19). It should be noted that selective attention is affected by inhibition and is associated with it because one who can't inhibit his behavior, distinguish intended stimuli among different stimulus and select it reflectively. The child who has difficulty in this function may be distracted and act impulsive. He may add extra letters to a word (20).

To date, four large meta-analysis studies have examined the performance of children and adults with attention deficit hyperactivity in the Stroop test. But in contrast to these findings, Van Mourik (2005) reported insignificant effect on performance of children with this disorder in this test. In the case of interference control, results indicate that there are differences between children with attention deficit-hyperactivity and normal children but this difference is not statistically significant. This result isn't consistent with the investigations were done by 2 studies (6, 21) that all confirmed deficit in inhibition of persons with attention deficit-hyperactivity. One of the reasons that can lead to lack of congruence between findings is confounding variables or psychotherapy or pharmacotherapy impact on the performance of children. On the other hand, methodological differences between studies, including the sample size, implementation methods and grading and how to extract interference score could also explain matter.

4.1. Limitation and suggestion

Future research can examine this important structure in these children by extending the sample and control of confounding variables.

According to the above results, following suggestions are presented:

- Addressing attention and memory problems should be first therapeutic measures for these children, and teachers of this group of children can consider training of attention and working memory as a new approach in the treatment of these two disorders in treatment planning.

- Providing training to improve executive skills and ultimately increasing attention and adequate support during the task.

- Computer and computer games should be used to train attention skills.

It is suggested that in future studies, three forms of this disorder are investigated in three distinct groups. This causes that presence or absence of attention deficit disorder in triple forms of attention deficit hyperactivity disorder is identified and possible differences of deficit profile of executive actions in three mentioned forms are determined. It is suggested that in future research, in addition to matching persons based on age, sex, familial status (economic and cultural) and the type of consumed drugs, conditions and requirements provided for random sampling to avoid non-random selection restrictions.

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