



## The effectiveness of sensory integration, emphasizing the proprioceptive and vestibular senses on children academic achievement suffering from Attention deficit hyperactivity disorder

Mojtaba Ebrahimi<sup>1</sup>, Ataallah Amin<sup>2</sup>, Seyed Mostafa Salari<sup>3</sup> and Fatemeh Danaiefard<sup>4</sup>

*1 MA in Psychology and education of Exceptional Children, University of Social Welfare and Rehabilitation Sciences, Tehran, Iran*

*2 MA in Clinical Psychology Azad University, Garmsar, Iran*

*3 MA in General Psychology Tehran University, Tehran, Iran*

*4 Special Education, Ministry of Education of Semnan Province, Semnan, Iran*

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### ABSTRACT

*This paper aims to investigate the effect of sensory integration of the proprioceptive and vestibular senses children academic achievement suffering from attention deficit hyperactivity disorder. In doing so, 32 students were selected among 6 – 12 years old children suffering from Attention deficit hyperactivity disorder in Semnan after applying study entry and exit criteria were selected randomly and divided into two 16 peoples of test and control groups. Test group members received sensory integration intervention (emphasizing the proprioceptive and vestibular senses) during 12 two hours sessions, twice a week and academic achievement of both groups was evaluated using teacher child symptom inventory (CSI4). Results showed a significant impact of sensory integration emphasizing the proprioceptive and vestibular senses on academic achievement of patients suffering from attention deficit hyperactivity disorder and the scale of this effect, particularly in reading and spelling components has been significantly evaluated 16% and 38/3 %, respectively.*

### Keyword:

Sensory integration, vestibular and proprioceptive senses, attention deficit, hyperactivity and impulsivity.

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\* Corresponding author: *Ebrahimi*

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## INTRODUCTION

Attention deficit hyperactivity disorder is one of most common disorders in childhood which has attracted much research attention to itself. This complex disorder which its etiology is based on biological factors, not only affects one's performance in various aspects, but it also affects family and its members and its prevalence is 3 – 7%. (1) This common disorder is described by three main symptoms of attention deficiency (short attention span approximately equal to one third of peers') hyperactivity (Agitation, not getting calm, the trouble of sitting in one place) which is the most evident behavioral feature of these children and impulsivity (action before thinking, weakness in planning and low tolerance of failure) which is detectable before 7 years old (2). To establish detection, this dysfunction must be durable at least 6 months and it must be manifested in both school and home environment and make problems in Social and academic performance of the child. In terms of infection rate, the number of infected boys is estimated three times more than girls and this disorder will be continued in 50 – 80% of sufferers until their adolescence period and 30 – 50% of them it will be continued to their adulthood. (3) Diagnosis and treatment of this disease, because of the risks associated with criminality, drug dependency, conduct disorder and coping behavior is of great importance. Research has shown that 30 percent of children suffering from attention deficit hyperactivity disorder have coping behavior disorder indices and 20 percent of them have conduct disorder criteria and most of families who have such children are confused (4). Deficiency in attention and focus and their impulsivity condition leads to disorders in their learning. And these children require specified education systems and their school grade point average compared to their norm classmates is lower. The children's academic problems are abundant and are not limited to a particular domain. Also, 70% of these children who are suffering from attention deficit hyperactivity disorder have learning disorders in most cases appear in writing dysfunction. (5) Furthermore, attention deficit hyperactivity disorder often accompanies with secondary symptoms such as aggression, social incompatibility and conflicts with peers and anti-social behavior. (6) Regarding the mentioned items, finding effective treatments for prevention strategies of extending problems of these children is one of other main lines of research in this domain. Different drug therapies, cognitive, behavioral, and combined and complementary are used for the treatment of attention deficit hyperactivity disorder. The most common drug therapies for children who are suffering from attention deficit hyperactivity disorder are central nervous system stimulant drugs which have side effects such as loss of appetite, weight loss, headaches, and even damage to brain neural tissues along with their beneficial effects in various areas of cognitive, academic achievement, family relations. (7) Cognitive-behavioral interventions is another therapeutic method which helps the child to improve his problem-solving skills and Control that was not very successful due to child's lack of cognitive and metacognitive functions. But when this method is used simultaneously with drug therapy, sufferers' impulsivity will be reduced and it can be used as a supplementary approach. (8) Behavioral therapy is another method in which

behaviors of children suffering from attention deficit hyperactivity disorder can be changed using positive and negative reinforcing, shaping, proximity, exclusion and modeling methods. Because the role of physiological factors creating behavior has been overlooked, it can lead to the manifestation of abnormal behaviors. (4) Among the various treatments, we can refer to sensory-motor integration activities i.e. the sensory controlled stimuli as self steering and meaningful activities which has a key emphasis on the role of biological drives for motivating confirmative behavior (9). A combination of both senses is used in sensory-motor integration activity of vestibular and proprioceptive senses. Vestibular and proprioceptive senses aren't used individually for two reasons: 1. because labyrinth system and its inputs are themselves a specialized kind of inputs pertinent to proprioceptive sense and 2. In many evaluations carried out in by therapists at clinics don't enable them to carefully distinguish the role vestibular system has in motor performances and the role proprioceptive sense has in this field. (10) despite the high prevalence of hyperactivity and attention deficit disorder and the scope of its influence, and the expectation the integrity of the sensory-motor effectiveness on symptoms of attention deficit hyperactivity disorder, a little research has been conducted on the effect of sensory-motor integration on the academic achievement of children suffering attention deficit hyperactivity disorder in Iran. In this research, the effect of sensory-motor integration, emphasizing vestibular and proprioceptive senses on academic achievement of 6 to 12 years children was studied in Semnan County. Because of conducting research in a natural environment and not controlling all disturbing variables, the present research is semi-experimental and has used pretest and posttest in control group.

## Methods and materials

The study population included all students suffering from attention deficit hyperactivity disorder in the academic year 1390-1391 who were studying in special schools in Semnan. After coordination with the mentioned county Department of Education, a meeting was held in the presence of parents of students suffering attention deficit hyperactivity disorder in order to calling cooperation and coordination. After required informing and getting students written consent for participating in research and their parents, 32 of whom had required qualification for entering to the study (including infection of attention deficit hyperactivity disorder, according to students records, ranging in age from 6 to 12 years, drug therapy) were selected among all 6 to 12 years male and female students suffering attention deficit hyperactivity disorder who were studying in Semnan special schools and randomly and simply were divided into two experiments (n = 16) and control (n = 16) groups. In this study, continuous absence in therapy sessions, existence of serious sensory deficiencies (visual and auditory) and motor (which prevents considered activities to be accomplished), the existence of associated disorders such as autism, mental retardation and child benefit of the mentioned therapy method in the past (according to teachers, parents and the material inserted in the file) as the exclusion criteria of the study were considered, then child symptom inventory (CSI-4) was completed by teachers and students participating in

the study. Sensory-motor integration intervention emphasizing vestibular and proprioceptive senses was done during twelve 2 hours group sessions, twice a week for six continuous weeks in which students actively accomplished considered activities. During this period, the control group only participated in school educational programs. After finishing the intervention sessions, in order to perform post-test, child symptom inventory was filled out by teachers and students participating in the study again. In order to observe ethical morals, an intervention session was held control group students and a little training in this regard was given to their parents, too. considered exercises by observing some matters such as ensuring strong and safe connections of vehicles, coverage of treatment floor with mattress, the existence of enough space in doing exercises, based on training related to vestibular and proprioceptive senses for sensory-motor integration intervention sessions emphasizing on vestibular and proprioceptive senses (adapted from the book of activities related to sensory-motor integration, Barbara Fink) include the following:

- 1- Performing swinging activities (swing with five meters per second speed for three to five minutes) on a balanced swing
  - 2- student sitting on a swing and twisting it around at a rate of one orbit in three to five minutes,
  - 3- games in the ball pool (placement and immersion of the student in groups of two or three people in the ball pool),
  - 4- Jumping on Trampoline for three to five minutes,
  - 5- twirling the student toward himself for twenty to thirty seconds in room open space and its repetition for three times.
  - 6- Child revolving around the coach using a rope for three times in a session and any time for 20 seconds.
  - 7- Sitting students on a thick carpet together and moving by their ass on the ground without getting help from hands for twice in any session and any time a distance of 12 meters.
  - 8- Sitting students on a hanging cradle and swinging forward and backward and hitting coach hands and knees with your body simultaneously
  - 9- Child walking with his hands for nine meters with the help of other students or the coach in the tournament and the game format
  - 10- Pushing a sitting student inside a cartoon in three-meter length and for a minute by another student.
- It is to be noted that during any activity it was asked from the student about the process of activity to ensure his comfort while he is doing the task and if a child didn't want to do a task, there was no compulsion to do

all activities by the child and they will be followed by him in next training session.

**Data collection tools:**

(A) demographic questionnaire: Data including age, gender, level of education, diagnosis contained in the file and used drugs.

(B) The fourth edition of child symptom inventory: (CHILD SYMPTOM INVENTORY-4)

In this research, child symptom inventory for evaluating attention deficit hyperactivity disorder symptoms was used which is a behavior grading scale whose initial form was designed in 1984 for riddling 18 children behavioral and emotional of 5 – 12 years old and slight changes were made according to DSM-IV in 1994 and it was released in the name of CSI-4. This scale has two parents and teacher forms whose teacher form contains educational environment and children's educational performance data is designed by 77 questions for riddling 9 behavioral and emotional disorders. CSI-4questionarie is adjusted for attention deficit hyperactivity disorders, obstinacy, disobedience, conduct, anxiety and tic, psychosis, mood disorders, pervasive developmental, social phobia, separation anxiety and disposal. This questionnaire has two scoring method in screening method in a 4 level scale never = 0, sometimes = 0, 1 = most often = 1, is scored and in a scoring method is scored in terms of disease symptoms in a 4-level scale of 0 = never, 1 = sometimes, 3 = often, 2 = Most of the time, and then severity score is obtained from the sum of scores for each question score. In this research micro tests of the CSI-4 questionnaire were used for measuring symptoms of attention deficit, hyperactivity and impulsivity. This micro test consists of 18 items that questions 1 to 9 identify dominant negligence and the questions 10 to 15 identify dominant hyperactivity, and the questions 16 to 18, identify dominant impulsivity (in each parents and teachers questionnaires). Child symptom inventory sensitivity (CSI-4) is determined 77 for attention deficit hyperactivity disorder (which is used in this study). Validity of this questionnaire was investigated in the method of reimplementatation of the test with 6 weeks intervals on 75 six to ten years old boys whose scoring method for ADHD was 67% and 76%, respectively. (11)

**Results**

Based on obtained results of descriptive indices (table 1) it can be stated in such a way that the mean of both control and experiment group in pretest stage is not very different.

Table. 1. Descriptive data of academic achievement scores on pre-test and post-test stages.

Variable	Control group				Experimental group			
	Pre-test		Post-test		Pre-test		Post-test	
	Mean	Std. Deviation	Mean	Std. Deviation	Mean	Std. Deviation	Mean	Std. Deviation
Reading	1.31	.479	1.31	.479	1.50	.516	2.19	.655
writing	1.87	.719	1.87	.719	1.81	.750	2.00	.816
Spelling	1.81	.750	1.81	.750	1.87	.719	2.44	.727
Mathematical	1.50	.516	1.50	.516	1.31	.479	1.62	.619
total score	6.50	1.414	6.50	1.414	6.50	1.414	8.25	1.528

Also, based on obtained results of descriptive indices it can be stated in such a way that the mean of both control and experiment group in pretest stage are different and shows increase in sample people scores in experiment group. The mean of the experimental and control groups at posttest

scores of the subjects in the experimental group increased there, and it shows. Kalmogorov– Smiranov Test was used for investigating the normality of scores (Table 2), according to obtained values the condition of equality of intragroup variances and normal distribution of the data is

held. Covariance homogeneity assumption of pretest scores of both groups was evaluated using Levine's test (Table 3).

Table 2. The investigation of data distribution normality using Kalmogorov– Smirnov Test

Variable		Kolmogorov-Smirnov test		
		Score	df	Sig.
total score	Control	0.142	16	0.200*
	Experimental	0.147	16	0.052

Table 3. Levine's test results for investigating homogeneity of covariance Intragroup tests

Variable	F	df1	df2	Sig.
total score	0.371	1	28	0.547

Regarding obtained results of covariance homogeneity assumption of data and holding regression slope was inferred. Regarding the nature of the used instruments of multivariate covariance analysis test is used to examine the hypothesis of covariance homogeneity. Regarding table 4 data, since the value 11.308 F= with freedom degrees (1, 30) is meaningful in  $\alpha = 0.05$ , therefore, it can be concluded that sensory integration activities affect the academic achievement of students suffering from attention deficit hyperactivity disorder and it shows that the effect of sensory integration activities on the academic achievement of children suffering from attention deficit hyperactivity

disorder is 27.4 percent and the amount of 902/0 is exponent of the test showing the adequacy of the statistical samples. Therefore, research assumption will be confirmed by 90% certainty. Mean comparison of experimental groups and control groups shows that the mean of the experimental group in the post test stage has increased. Therefore it can be concluded that sensory integration activities affect the academic achievement of children suffering from attention deficit hyperactivity disorder. Particularly in reading and spelling components, effectiveness of sensory integration activities on academic achievement of students suffering from attention deficit hyperactivity disorder has been significantly increased 3/38% and 16% respectively.

Table 4. The results of covariance analysis about research hypothesis (n=32)

Index	Total squares	df	Mean square	F	Sig.	ETA coefficient	test power
changes resources							
Effects							
Group							
Reading	6.125	1	6.125	18.608	.000	.383	.987
writing	.125	1	.125	.211	.649	.007	.073
Spelling	3.125	1	3.125	5.725	.023	.160	.639
Mathematical	.125	1	.125	.385	.540	.013	.092
total score	24.500	1	24.500	11.308	.002	.274	.902
Error							
Reading	9.875	30	.329				
writing	17.750	30	.592				
Spelling	16.375	30	.546				
Mathematical	9.750	30	.325				
total score	65.000	30	2.167				

## Discussion

Almost half of the children suffering from attention deficit hyperactivity disorder are impaired in balance and coordination and their vestibular system and cerebellum is involved. Brain scanning of these children confirms this and because cerebellum and basal ganglia are effective for motor control and cognitive and emotional functions. Dysfunction in this part of the children brain can explain deficits in motor and cognitive levels (12). On the other hand, vestibular system is among the first system that is formed in the early fetal life, about twenty weeks. Different functions of the body such as coordination in movements, balance, and movement in space, the level of consciousness adjustment, memory, growth, and speech development are related to the proper functioning of the system. Therefore, they have important role in growth and the evolution of humans (13). The relationship vestibular system has with the central nervous system describes its role. Vestibular system with reticular formation which is involved in consciousness

level adjustment and selective attention is related with thalamus which is involved in the integration of sensory input.(14) According to conducted research, some problems of children suffering from attention deficit hyperactivity disorder is caused by the reticular formation disorder which is called the turn on key of the human brain and is the center of processing entered sensory information has a role in consciousness, motivation, learning, self-control or impulsivity and is responsible for filtering incoming information from the body and environment like feelings that without its exact functioning, the person becomes confused with every stimulus and because the grid system is not working properly in children suffering from attention deficit hyperactivity disorder, any stimulus will draw the children's attention and make them away from the specified path.(15) The obtained results of this study confirm Vergas and Kameli research (1990)(16) on the effectiveness of sensory integration therapy on mental and motor skills in children, Alizadeh (2001)(9) on the effect of sensory integration on motor skills, planning and students' academic

achievement, Robert et al.(2007)(17) on the effect of sensory integration on improving the behavior adjustment, Walting and Dietz (2007)(18) on the effect of sensory integration intervention on reducing undesirable behaviors in children suffering from autism and Chu (1996)(19) on the usefulness of sensory integration in relation with certain developmental disorders in children. In order to explain treatment impact of proprioceptive and vestibular integration activities on children's educational achievement, It can be stated that the integration of proprioceptive and vestibular affects the upper surface function of the brain which is responsible for accomplishing supreme processes such as attention and improves the organization of children receptive senses from surrounding environment and stimuli (Ayres 1989)(20) in such a way that spatial and temporal aspects of sensory input will be processed, related and combined and the brain will select, boost, halter and compare and it will integrate them in a flexible and changeable pattern. Therefore, it improves responding process of these children just to a stimulus and controlling other environmental stimuli and it smoothes some disabilities of children who are suffering from social behaviors and academic achievement and it can cause significant positive results in their daily lives.(21)

Also, processing of intervention group children has improved by doing sensory integration activities and caused optimal action including, planning ability and implementing new motor actions and appropriate interaction with the environment (Cermack and Mitchell 2006).(22)

To sum up, the obtained results of this research confirmed other research activities concerning the effects of sensory integration activities. These findings can be useful and effective for therapists and they are able to be implemented in exceptional education system.

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