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An investigation into the social and behavioral interactions of kids with autism and their perspectives on the topic of sensory training

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Abstract

Autism spectrum disorder is a type of neurodevelopmental disorder, so this disorder is characterized by severe impairment in social interactions, poor communication skills, and stereotyped behaviors. Furthermore, we obtained the imaging data from the ABIDE II database in order to investigate the association between total brain volume and Social Responsiveness Scale (SRS-2) in autism. The present study was conducted with the aim of investigating the effectiveness of sensory integration exercises on social interactions and stereotyped behaviors of children with autism spectrum disorder. For this purpose, a semi-experimental design of pre-test-post-test type was implemented with experimental and control groups. The statistical population of the research included 5-12-year-old students with autism spectrum disorder in 2023. Using the purposeful sampling method, 26 people were selected from them and were randomly placed in two experimental and control groups (13 people in each group). The experimental group received sensory integration intervention for 12 sessions, three days a week and each session lasted 45 minutes, while the control group did not receive any intervention. To collect data, before and after the intervention, the revised scale of repetitive behaviors and the social interaction questionnaire were used. The data was analyzed using multivariate analysis of covariance by SPSS 25 software. The findings of the research showed that after the intervention, there was a significant difference in the scores of stereotyped behaviors (0.001) and social interactions (0.015) between the two groups. In general, it was found that sensory integration exercises reduce stereotyped behaviors and improve social interactions. Therefore, it is suggested to use sensory integration exercises to improve social interactions and reduce stereotyped behaviors of children with autism spectrum disorder.

Keywords: Autism spectrum disorder, Sensory integrity, stereotyped behaviors

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Introduction

Autism spectrum disorders (ASD) are a set of neurodevelopmental disorders characterized by deficits in communication and social interaction, in addition to limited interests and stereotyped behaviors (16). Characteristics of children with autism spectrum disorder (ASD) typically include behaviors such as hand flapping, spinning, withdrawing, rocking, ear covering and intense staring, interest in light, and visual stimuli. These behaviors, which are usually referred to as sensory features, are present in more than 80% of people with autism spectrum disorder (23). Also, children with autism spectrum disorder show a series of challenging behaviors (26) such as aggression, incompatibility with the environment, and self-harm. One of the types of challenging behaviors is stereotyped and stereotyped

movements that somehow involve the motor organs (19). Self-stimulating or stereotypic behavior is a repeated movement of the body that does not have a specific purpose in the external environment. These behaviors often interfere with the individual's ability to function independently disrupt the individual's ability to communicate, learn, and interact adaptively with the environment (21), and cause problems in social, cognitive, and emotional development (10). Unpredictable behaviors such as screaming, aggressive behaviors, and self-injurious behaviors (27). Among many studies, the cause of stereotyped behaviors is the dysfunction of the sensory processing system, which manifests as hypo-sensory (11). A person with sensory processing disorder uses self-stimulation to compensate for limited sensory input or to avoid overstimulation (21). Families report that sensory impairments significantly limit participation in daily activities (28) and cause social isolation for them and their children (26). Another factor that can limit the participation of these people in daily activities is low social functions, which is one of the main characteristics of these people (3).

Research has shown that children with autism disorder have defects in social interactions and have problems with language, eye contact, lack of smiling, impairment in asking and responding to questions, problems in starting and maintaining social interactions, and sharing pleasures and happiness with others. These problems cause low progress in occupational and academic fields, anxiety, difficulty in learning, dependence, stereotyped behaviors, aggression, rejection of peers, and social isolation (20).

Qualitative social impairments such as limited social cognition and lack of social skills make these children unable to initiate and maintain social interaction (3) and (4). Research, (14) showed that children with autism spectrum disorder have unusual disorganization in social interaction and sensory processing. Also: (1) showed in research that children with autism spectrum disorder face problems in terms of social

Table 1. Summary of sessions of sensory integration exercises based on the Ayers program

session	content
First session	Tools such as CP ball, acrobat net, swing, and balance ladder were used to stimulate the sense of touch, balance, and depth perception.
Second session	Children's sense of touch was stimulated by pressing play dough, crumpling newspaper, and pushing heavy objects.
third session	Children's sense of depth perception was stimulated by using a CP ball, pushing heavy objects, and swinging.
4th Session	To stimulate the sense of balance, walking on a narrow edge, standing on one leg and walking sideways were used.
5th meeting	To re-stimulate the sense of touch, exercises such as walking on surfaces with different roughness and softness, rolling, crawling were used.
6th session	To re-stimulate the sense of proprioception, jumping on the acrobat net, tug-of-war and lilly were used.
7th session	Palm massage, play dough pressing, finger painting and finger painting were used to re-stimulate the sense of touch.
8th session	Jumping on a moving rope, standing on a balance board, and jumping over obstacles were used to re-stimulate the sense of balance.
9th session	Shooting the ball, throwing the ball, standing on the balance board and pushing heavy objects were used to stimulate the sense of proprioception and balance.
10th session	In order to re-stimulate the sense of touch and balance, exercises such as crawling, rolling, and distinguishing rough and soft people inside the bag were used.
11th session	To stimulate the sense of touch and depth, pressing the ball on different parts of the child's body, pressing the tennis ball with the hand, and pushing heavy objects were used.
12th session	In order to stimulate the sense of proprioception, touch and balance, playing wolf in the air, jumping on the stairs, playing ball on the balance board, moving on a narrow path and jumping over obstacles were used.

Table 2. The mean and standard deviation of the two experimental and control groups in the pre-test and post-test

group	Variables	pre-test		post-test	
The experiment		Average	standard deviation	Average	standard deviation
	Stereotypical behavior	46.15	23.97	30.07	15.51
	Social interaction problems	74.61	8.85	65.69	12.69
	Stereotypical behavior	46.69	24.09	45.92	23.53
Control	Social interactions	74.53	9	74.23	8.69

interactions, stereotyped behaviors, and communication skills. Due to the problems that children with autism spectrum disorder create in the field of skills related to social interactions, communication skills with others and the existence of stereotyped behaviors and activities for themselves and those around them, various approaches and methods have been proposed to treat children with autism spectrum disorder. Among the treatments, Ayers' sensory integration approach can be mentioned (9).

Ayers' theory of sensory integration was developed in 1970 and is based on the neural processing and integration of sensory information (17). One of the main advantages of this treatment is that it can lead to the reduction of abnormal behaviors (5). During therapy with the sensory integration method, an autistic person is tried to be led towards activities that challenge his ability to respond successfully. Ayers stated that the sensory system grows over time, just like other developmental aspects (language, movement, etc.) and this defect in integration can show itself well in the process of sensory development. An integrated sensory system can well integrate input information from different sources (visual, auditory, or vestibular). Ayers hypothesized that sensory integration disorders occur when sensory neurons do not signal or function effectively, which leads to impairments in development, learning, or emotional regulation (2).

The process of sensory integration is created by performing rehabilitation exercises and sports exercises. By using regular and purposeful exercises, you can see improvements in children's sensory-motor skills. Rehabilitation specialists consider sensory integration therapy to be a suitable and effective way to treat these disorders (7). (17) investigated the effect of sensory integration interventions in 6- to 12-year-old autistic children. The result of their research showed that sensory integration interventions had significant results in motor skills, sensory processing, and emotional factors. Also, in research, (12) showed the effectiveness of the sensory integration method in reducing stereotyped behaviors of children with autism spectrum disorder. The sensory integration method reduces stereotyped, obsessive, ritualistic, monotonous, limited, and self-harming behaviors of children with autism spectrum disorder. Since impaired sensory integration is a major problem in autistic children, these children have a strong need for perceptual-motor activities to overcome their problems. In this regard (24) confirmed the effect of Ayers's sensory integration method in improving the behaviors of preschool children with autism, especially in behaviors such as social interactions and eye contact. Also, based on the research (8), highlights this one there is a significant knowledge gap between infant and adult action identification areas and (25) also investigated the effect of the sensory program on the interactions of adolescents with intellectual disabilities in research. Their results showed that the sensory program was effective on their happiness and social interaction.

Considering the widespread impact of sensory-motor abnormalities on the social, academic, and communication function of people with autism spectrum disorder, as well as the importance of treatment in the first years of life and reducing the imposition of heavy costs on the family and society, it seems necessary to provide intervention programs to moderate their problems.

The use of sensory-motor interventions strengthens the sensory systems and the flexibility of the cognitive nervous system and modifies behavioral problems such as self-harm, self-stimulation, etc., as well as improving the social interactions of children with autism. Therefore, the present study was conducted with the aim of investigating the effectiveness of sensory integration exercises on social interactions and stereotyped behaviors of children with autism spectrum disorder. Furthermore, we obtained the imaging data from the ABIDE II database in order to investigate the association between total brain volume and Social Responsiveness Scale (SRS-2) in autism.

Methods

The method of conducting this research was quasi-experimental and of pre-test-post-test type with a control group. The statistical population of the research consisted of all students aged 5 to 12 years (boys and girls) with autism

Table 3. General results of multivariate covariance analysis on the average difference between pre-test and post-test scores in the experimental and control groups.

Test type	amount	Hypothetical df	df error	F	P
Pillai's work	0.38	2	21	6.69	0.006
Wilks Lambda	0.61	2	21	6.69	0.006
Hotelling's work	0.63	2	21	6.69	0.006
The largest zinc root	0.63	2	21	6.69	0.006

spectrum disorder with low performance in 2023.26 students were selected as the research sample. Due to the limited sample, the members of the sample were selected by the purposeful sampling method and were randomly divided into two control (13 people) and experimental (13 people) groups. The criteria for entering the study were: autistic students with low-level performance, volunteering to enter the study (completion of the consent form), age range of 5-12 years, no co-occurring disorders, and no history of sensory-motor integration training intervention. The criteria for leaving the research were non-cooperation during the intervention or parents' desire to stop the intervention and the absence of more than two sessions in the educational sessions. Both groups were then pre-tested using the revised scale of repetitive behaviors (21) and social interactions (21).

In this way, the parents completed the questionnaire before and after the intervention. After the pre-test, the students of the experimental group received Ayers' (1974) sensory integration therapy intervention during 12 sessions, four weeks, and 3 sessions each week for 45 minutes. Immediately after the end of the intervention, the parents of both groups answered the questionnaires again and the results were analyzed using SPSS 25 software.

ABIDE II

Structural MRI data were obtained from the publicly accessible image repositories BNI (http://fcon_1000.projects.nitrc.org/indi/abide/abide_II.html). These repositories were selected due to their inclusion of adult structural MRI datasets. All participants provided written informed consent and underwent scanning procedures that were approved by the local Institutional Review Boards (IRB) at each participating institution.

The ABIDE II database compiles imaging and behavioral data from various studies, focusing on individuals diagnosed with ASD and their typically developing peers. For this study, we specifically selected the BNI dataset from ABIDE II, which at the time of data retrieval included 58 adult males, both with ASD and neurotypical. This comprised 29 males with ASD, aged 18-65 years (mean age: 37.5 ± 16 years), and 29 age- and gender-matched neurotypical controls, aged 18-65 years (mean age: 39.6 ± 15 years). All participants were right-handed males. The ASD diagnosis was confirmed using the Autism Diagnostic Observation Schedule-2nd edition (ADOS-2) by a qualified clinician. Participants had IQs within the normal range or up to one standard deviation below the mean, assessed via the Kaufman Brief Intelligence Test-2nd edition (KBIT-2). Exclusion criteria for both groups included MRI scanning contraindications and full-scale IQ scores more than one standard deviation below the mean on the KBIT-2. Additionally, neurotypical subjects were screened for any history of psychiatric or neurological disorders, immediate family members with ASD, or other significant medical conditions that could impact brain function. The SRS-2 scores were obtained from ABIDE II.

Research tool

Revised Scale of Repetitive Behaviors (Budfish, Simmons, Parker & Lewis, 2000)

This scale was designed by Budfish, Simon, Parker, and Lewis in 2000 to assess repetitive behaviors. This scale has 43 items on a four-point Likert scale (never = 0, sometimes = 1, most of the time = 2, and always = 3). The mentioned scale has six subscales of stereotyped behavior, self-injurious behavior, obsessive behavior, ritualistic behavior, monotonous behavior, and limited behavior (15), (21) have reported the reliability of the revised scale of repetitive behaviors using the internal consistency method (Cronbach's alpha) for subscales from 0.78 to 91. Also, these researchers have reported the validity of the scale using the internal correlation method between 0.57 and 0.73 (6).In the research of (21), the reliability of the revised scale of repetitive behaviors was estimated using Cronbach's alpha coefficient for the whole scale as 0.92. Also, the construct validity obtained based on the correlation method between the whole test and its sub-tests was obtained

Table 4. The results of covariance analysis and post-test comparison in two groups by controlling the pre-test effect of stereotyped behaviors

Source of changes	sum of squares	degree of freedom	mean square	F	Sig	Eta squared
pre-exam	6778.35	1	6778.35	56.57	<0.001	0.71
group	1555.29	1	1555.29	12.98	0.001	0.36
error	2755.89	23	119.804			
Total	48710	26				

from 0.68 to 0.98. Cronbach's alpha coefficient of this research was calculated as 0.93.

Questionnaire of social interactions (5 to 15 years): (Kadjeau, Janols, Kirkman, Michelson, Strand, Trillingsgaard, Gilberg, 2004)

This questionnaire was created in 2004 in Northern European countries with the aim of drawing the problems of children and adolescents aged 5 to 15 years.This questionnaire has 181 items, and the social interaction subscale of this questionnaire, which was used in this research, has 17 items that parents mark with "does not use" and "sometimes uses" and "uses".The items are graded in such a way that (does not use) gets a score of 1, (sometimes uses) a score of 2 and (uses) a score of 3.These 181 items are arranged in 8 areas that cover motor skills, executive functions, perception, and memory, language, learning ability, social skills, emotional and behavioral problems.The domains can be divided into 22 subscales.These subscales examine gross and fine motor skills, attention, hyperactivity and impulsivity, planning, spatial perception, memory, perception, speech, communication skills, general learning, skills during learning, etc. (18). Rathi has used content-dependent validity to measure the validity of the social interaction subscale of this questionnaire. The reliability of this subscale was 0.96 using Cronbach's alpha method. Also, Cronbach's alpha of this research was calculated as 0.89.

Introducing the sessions of the sensory integration treatment program: At the beginning, while explaining the objectives of the research to the mothers, written consent was obtained from the parents for their children's participation in the research.Also, ethical points such as voluntariness, absence of physical and mental harm to children and confidentiality were considered in the research process.Then the researcher and occupational therapist of the center prepared the sensory integration program and the coach was taught how to do the exercises.The attendance schedule of the students was arranged with the supervisor of the center so that it does not interfere with other programs of the center. Sensory integration exercises were performed by the center's trainer and under the supervision of the center's occupational therapist in the occupational therapy room for one day and three sessions per week for a period of 45 days. A summary of the considered exercises while observing things such as ensuring that the equipment is safe, covering the floor of the training place with a mat, and sufficient space based on the exercises related to the vestibular, depth, and tactile senses includes the following:

Research findings

In terms of demographic characteristics, in terms of gender, the number of boys and girls in the experimental group was 8 and 5 (61.5 and 38.5 percent), respectively, and in the control group, there were 7 and 6 (53.8 and 46.2 percent). The average age and standard deviation of the subjects of the experimental group were 8.3, 2.42 and the control group were 2.36, and 8.08, respectively.

Also, the age range of both groups was from 5 to 12 years. Multivariate analysis of the covariance test was used to check the significance of the difference between the averages of the two groups. Before expressing the results of analysis of covariance analysis, the assumptions of parametric tests were evaluated. Based on this, the results of the Kolmogorov-Smirnov test were equal to 0.20, which indicated that the assumption of normality of the sample distribution of the data was established ($p>0.05$).

Also, the assumption of homogeneity of variances was measured with Levine's test, which was equal to 0.11 and its results were not significant. Therefore, the assumption of homogeneity of variances has been met ($p>0.05$). The results of covariance analysis to investigate the effect of the intervention on the experimental group are reported in Table 2.

Results

Table 5. Table of covariance analysis test results and post-test comparison in two groups by controlling the pre-test effect of social interactions

Source of changes	sum of squares	degree of freedom	mean square	F	Sig	Eta squared
pre-exam	1240.24	1	1240.24	17.95	<0.001	0.43
group	480.77	1	480.77	6.96	0.001	0.23
error	1588.83	23	69.08			
Total	130563	26				

The mean and standard deviation of the stereotyped behaviors and social interactions of the experimental and control groups are shown in Table 2.

The significance of the multivariate test indexes, namely Wilks's lambda, Hotelling effect, the largest specific root of zinc, and Pillai effect ($p < 0.05$, $F = 6.69$) confirms that there is a significant difference in at least one of the components. The results of Table 4 show that the hypothesis of the effectiveness of the sensory integration training program on stereotyped behaviors has been confirmed ($p<0.05$). Also, the effect size is reported as 0.36, which shows that 36% of the variance changes are caused by the independent variable. The results of Table 5 show that the hypothesis of the effectiveness of the sensory integration training program on social interactions has been confirmed ($p<0.05$). Also, the effect size is reported as 0.23, which shows that 23% of the variance changes were caused by the independent variable.

Results of ABIDE II

Investigating the relationship between SRS-2 score and total brain volume showed a significant positive correlation ($p<0.05$).

Discussion

The present study was conducted with the aim of investigating the effectiveness of sensory integration exercises on social interactions and reducing stereotyped behaviors. The analysis of the results shows the positive effect of the intervention of sensory integration exercises on the social interactions and stereotyped behaviors of the experimental group. This finding is in line with the results of (17), (14), (9), (28), and (25)

Hypersensitivity to sensory features received in these children can cause an inability to filter out additional information. Also, it can lead to delays in visual and auditory processing and failure to respond appropriately. Socially, this sensory sensitivity profile can affect selective attention to social stimuli, decoding, social reciprocity, and adherence to social norms. (13) stated in their research that the deficit in social interaction in children with autism spectrum disorder can be caused by a disorder in the sensory integration system. When children can modulate and regulate sensory information, they can easily achieve an optimal state to participate in social interaction and develop appropriate activities. Also, children with autism disorder are not able to create a clear perception of their body; because they do not receive enough sensory information from the skin, muscles, joints, and vestibular system; therefore, they have problems interacting with their living environment or with others. Sensory integration exercises reduce sensory and behavioral problems such as self-stimulating behaviors and anxiety; As a result, these children can communicate with others more easily. Also, (21) investigated the effect of group and individual sensory and motor integration activities on perceptual-motor ability and social development of autistic children. Their results showed that the group and individual activity program was effective on motor perception ability compared to the control group.

In explaining these results, it can be said that appropriate sensory and motor integration activities help physical growth and motor behavior development, and finally, the development of these skills leads to the development of children's social behaviors and leads them to acceptable and desirable social standards. A child needs a complete repertoire of functional actions to engage in social interactions. Poor coordination and crude movements of children with autism spectrum disorder negatively affect their social participation. An example of children with ASD is that uncoordinated and slow head movements can affect timely and effective head turning, reaching, pointing, and object pointing, which are important in responding to social interactions with others.

In research aimed at investigating the effectiveness of sensory integration exercises on reducing stereotyped behaviors of children with autism spectrum disorder, (22) concluded that sensory integration exercises were effective in reducing stereotypical behaviors. In explaining these results, it can be

said that movement activities as a suitable substitute for repetitive behaviors play an effective role in reducing or eliminating them through sensory feedback similar to patterned behaviors. Therefore, the greater the overlap of motor activities with repetitive behaviors and the more targeted these activities are, the greater their impact will be. Some experts have raised the issue of sensory integration defects for independent children and they believe that any kind of insufficient activity of the sensory system, such as sensory overwork and sensory underwork, provides the basis for the occurrence of behaviors such as turning, shaking, and some movement abnormalities in the child. Although it is difficult to determine the specific cause of these behaviors, various theories have been developed to explain why they occur.

The first explanation is that these behaviors cause tactile and sensory stimulation of the person, which is not achieved through normal adaptive behaviors. Another explanation is that self-stimulating behaviors are used to regulate and adjust sensory information for people who have difficulty receiving and interpreting this information (21). The reduction of self-stimulating behaviors when using sensory integration is because it enables a person to process sensory stimuli without self-stimulation and increases the person's ability to process sensory information (17). Proponents of the theory of sensory integration believe that inappropriate or incomplete sensory processing is a developmental disorder that, if treated, can improve a person's development (2).

According to the results of the research and the present study, sensory-motor integration exercises improve the performance of children with autism spectrum disorder. Convenient training, saving money, not needing a lot of equipment and facilities, as well as easy implementation by children are the advantages of sensory integration exercises. Therefore, it can be said that sensory integration exercises are a safe and effective way to improve social functioning and reduce stereotyped behaviors in children with autism spectrum disorder. The present study showed that sensory integration exercises are effective in the development of social interactions and the reduction of stereotyped behaviors in children with autism spectrum. But this research has limitations such as the small sample size. The sample is limited only to children with autism spectrum from 5 to 12 years old, which makes it difficult to generalize the findings. Also, in this study, the follow-up period was not done; therefore, it is suggested that in future studies, researchers use larger samples and conduct follow-up periods to check the continuity of the effectiveness of the intervention. Also, it is suggested to carry out research to compare the effectiveness of sensory integration intervention with other therapeutic interventions for children with autism spectrum disorder.

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Conflict of interest

The authors declare no conflict of interest regarding the publication of this paper.

Availability of data and material

The datasets analyzed during the current study are available upon request with no restriction.

Consent for publication

This manuscript has been approved for publication by all authors.

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