

Effects of Vestibular and Tactile Stimulation on Behavioral Disorders due to Sensory Processing Deficiency in 3-13 Years Old Iranian Autistic Children

Elham Ghanavati; Mohammadreza Zarbakhsh*
Islamic Azad University, Tonekabon Branch, Tonekabon, Iran

Hojjat Allah Haghgoo, PhD.
University of Social Welfare and Rehabilitation Sciences, Tehran, Iran

Objectives: Among the most important problems of autistic children are the behavioral disorders due to sensory processing deficiency, which are typically reflected in behaviors such as impulsivity, attention and concentration disorders, undesirable emotional reactions, sensory seeking in the form of stereotype behaviors, self-injury and self-stimulating. The present study aimed at exploring the effects of a combined vestibular and tactile stimulation on behavioral abnormalities resulting from sensory processing deficiency in autistic children of an age of 3-13 years old.

Method: The study was an experimental research using a pretest-posttest design with a control group. Twelve autistic children of an average age of 8.4 year whose sensory disorders had been verified through the Winnie Dunn's Sensory Assessment Questionnaire, were randomly selected from two school for behavioral disorders. They were randomly grouped in two groups of 6 subjects, namely the Test Group and the Control Group. Then, participants in the experimental group received vestibular and tactile stimulation for 36 sessions, 3 sessions a week, each session of 45 minutes.

Results: The subjects in the control group were under the school's regular schedule. After intervention, they were assessed again and the collected data obtained were analyzed through Multivariable Covariance Analysis using the SPSS software, version 20.

Discussion: According to the findings obtained, the vestibular and tactile stimulation significantly decreases the behavioral abnormalities of autistic children afflicted with sensory processing deficiency ($p < 0.01$). Using the vestibular and tactile stimulation can be taken as an effective method in the treatment of autistic children.

KeyWords: Autism, Behavioral abnormalities, Vestibular Stimulation, Tactile stimulation, Sensory Processing Deficiency.

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Introduction

Autism is a developmental disorder with persistent symptoms ranging on a continuum. Primary theories have accounted for the disorder on the basis of psychological issues, but, nowadays, it is mostly believed that autism has neurological causes resulting in the emergence of sensory processing deficiencies in suffered individuals, typically reflected as disorders in social interaction, communication and language as well as abnormal reactions to the environmental stimuli. In general, autism is etiologically attributed to dysfunction of chromosomes 2, 4, 7, 15 and 19, and about 1% of

autistic children suffer the Fragile X Syndrome which is reflected in problems with gross and fine motors and with assertive skills (1).

Among models designed in regard with the etiology and treatment of autism including psychoanalytical models, neurological dysfunction models, biochemical models, and pharmaceutical treatment models, one may mention a new theory entitled as "information processing" approach focusing on autistic children's sensory function disorders (2). This modern theory which has managed to find some explanations the causes of autism, assumes that any organism establishes its own relationships

* All correspondences to Mohammadreza Zarbakhsh, Email: <rzarbakhsh@yahoo.com>

with the world and the reality through its nervous system. So, human being should be able to perceive or to feel environmental messages or information and translate them into a language which is comprehensible for the brain; as a matter of fact, human being is expected to recognize his status in the external world through the perception of such information and to act accordingly. If, however, there is a dysfunction in any stages of such a process (perception, transfer and translation of messages into a language comprehensible for the processor nervous system, as well as the perception of messages), then abnormal behaviors will evolved. Abnormal behaviors such as the attention deficit in autistic children, abnormal reactions to the environmental stimuli, and disorders in social or communicative, all result from the deficient processing of sensory inputs, since sensory processing is a critical prerequisite for children and plays an important role in their learning, activities of daily life performance and in their adaptation with the environment. Hence, sensory processing is dependent on sensory information received by the brain from different systems including tactile visual, auditory, proprioceptive and taste as well as body positioning. Perception of the outside world requires receiving, processing and interpreting sufficient sensory information perceived by sensory receptors. Sensory processing is the key point in sensory integration whereby different types of sensory information are processed and integrated to facilitate the expression of adjusted behavior. In most children, sensory integration is developed during their ordinary childhood activities and results in their adaptation with the environment and the emergence of appropriate behavioral movements; researchers have reported that weak sensory processing in autistic children will lead to disorders in their sensory, movement, cognitive and social development, and that their bodies' consistent stereotype behavior are a result of the weakness of sensory processing characterized as the lack of a too severe response or reaction to sensory inputs (3, 4). Having regarded such an approach, sensory integration has been introduced as a treatment method based on sensory perception that refers to one's ability for organizing (integrating) the information (i.e. the sensory inputs) in the brain stem, and such a treatment includes the stimulation of the child's skin and vestibular systems through suitable exercise practices (5). In this treatment approach, certain techniques are used whereby the

patient receives controlled sensory stimulations offered to him in the form of purposeful treatment activities so that, in the end, he may show accommodative responses to motor and non-motor behaviors. It is worth motioning that in this approach, the main focus is located on three different sensory stimulations including: (1) touch and tactile stimulation, (2) the proprioceptive (relevant to muscles, joints and tendons), and 3- the vestibular stimulation (3, 6, 7).

Accordingly, it could be expected that sensory stimulations might be effective in the improvement of behavioral abnormalities due to sensory processing disorder and in changing the levels of vigilance and thereby cognition, improving sensory processing and perception and as such, they would be expected to lead to autistic children's rehabilitation. So, the impact of making use of such stimulations on the improvement of behavioral abnormalities in autistic children was targeted in the present research.

Methods

The 12 male autistic children at the age of 3-13, were randomly selected among autistic children engaged in studying in two schools specific to children with behavioral abnormalities in Tehran in the period 2011-2012. All parents were asked to complete Winnie Dunn's Sensory Assessment Test (1999) for their own sons to evaluate and identify children with the disorder of sensory integration. So, the statistical population of the research included 12 almost homogeneous subjects who were randomly placed into two different groups of 6 children, experimental and control groups. Upon the completion of the sampling procedure, a coordination session was hold with the participation of parents where all stages of the interference to be followed was described and their written consents for the interference were acquired.

On the next stage, all exercises and the way they were going to be put into practice were practically administered on the children and the parents were taught to do the same later on. The touch exercises included relaxing touch, pressure touch, slow and fast itching touch, slow and fast hair touch, while vestibular stimulations included moving on a swing (in a linear movement backward and forward or in a rotating movement), jumping on a spring surface, slithering, moving to the right and left sides on a rotating armchair, and moving up and down on a flip-flop. Then, a training package was given to the

parents consisting of details of the stages and the way the exercises were to put into practice on a daily basis. Moreover, the intervention was individually administered by a trained therapist (i.e. the researcher) in the form of tactile and vestibular sensory stimuli for three months, 3 sessions a week, each session lasting for 45 minutes. In addition, the same exercises were followed up by the trained parents at home for three months on a daily basis.

The way the exercises were done by the parents and the way children reacted to them were assessed once a week as a phone contact and once again in presence, with the assessment reports being recorded with the consultation office. During the intervention period, the control group received the school ordinary programs. When the cycle of exercises was completed, once again the sensory profile of all participants were assessed using Winnie Dunn's Sensory Assessment Test and the pretest/posttest scores of the subjects were measured and analyzed through Multivariable Covariance Analysis (MANCOVA) Test using the SPSS software (Version 20).

Data measurement instrument- A demographic questionnaire was used to record characteristic information. For measuring the subjects' sensory profile, the Winnie Dunn's Sensory Assessment Test (1999) was used (8) . This questionnaire includes 125 items related to sensory variables and has been standardized in 1999 on the basis of behaviors observed in autistic children. Based on the factor analysis procedure, the items of the questionnaire were divided into 9 behavioral sensory areas including sensory seeking, emotional reactions, low endurance/toneoral sensory sensitivity, distraction

and inattention, poor registration, sensory sensitivity, sedentary , and fine motor/perceptual.

Scoring the test - All 125 items are scored on a Likert based scale of 1 to 5. Such scales assess the process of the visual sensory, auditory, the vestibular system, the sense of touch, multi-sensory processing, the oral sense, tone and strength of muscles, the motor and body positioning, the modulation of movements affecting activities, the modulation of movements affecting emotional reactions, the modulation of visual inputs affecting emotional reactions, the emotional reactions, the behavioral consequences of sensory processing and reaction threshold. Separate scores of these scales are finally summed up for each item, and the total score obtained in this way is compared to the mean score of the whole group to be used as the criterion for screening. For each subject the pre-test scores were compared to post test scores in all 9 factors of behavioral sensory areas. In so doing, the variable "poor registration" was quantified and compared as the sum of the scores obtained in three factors including low endurance/tone, poor registration and sedantary, while the variable "sensory sensitivity" was calculated and compared as the sum of scores of three other factors including sensitivity of the oral sensory sensitivity, distraction and inattention, and sensory sensitivity.

Results

Twelve autistic boys (mean age =7) from two school participated in this resrach. Statistics of dependent variables are shown in Table (1) for experimental and control group.

Table 1. Statistics for Dependent Variables in Both Groups after Interference

Variables	Experiment group Pre test		Experiment group post test		Control group pre test		Control group post test	
	Mean	S.D.	Mean	S.D.	Mean	S.D.	Mean	S.D.
Sensory seeking	47.9	6.63324	57.7	5.04645	48.8	4.70829	49.3	4.63321
Emotional reactions	37.8	2.78711	45.3	2.80476	38.5	3.78153	37.7	2.94392
Weak sensory records	61.0	9.35948	74.5	8.54985	62.1	4.16749	64.5	5.08920
Sensitivity to stimulation	55.0	6.61573	70.0	6.81175	54.8	1.83521	55.7	1.86190
Total	50.42	6.34889	61.87	5.8032	51.05	3.62313	51.8	3.6320

The results indicate that in the post-test, there has been a difference in the mean scores of the Test Group and the Control Group in regard with dependent variables, the difference being in the favor of the Test Group.

The results of the MANCOVA Test for investigating the effect of touch and vestibular sensory stimulations on the combinational variable, namely the behavioral abnormalities resulting from sensory processing dysfunction, have been reported in Table (2).

Table 2. MANCOVA Test of F Ratio for Measuring the Value of the Combinational Variable

Source	Value	F	Significance Level	Eta
Behavioral abnormalities	0.24	30.353	0.009	0.976

*The Multi-variable F Ratio has been calculated as an approximation of the Wilks Lambda value

The square quantity of Eta as reported in the above Table is a fraction of the variance which is related to the combinational variable, namely the behavioral abnormalities resulting from sensory processing dysfunction. The general rule is that if such a value is more than 0.14, the effect is taken as remarkable. In the above Table, the value for the combinational variable is 0.976 indicating that the effect is

remarkable. Moreover, the results of the Wilks Lambda Test in respect of the combinational variable is significant indicating that the participants of the two groups are different and that the groups mean scores have been affected by the interference. The results of the adjusted mean and the results of the covariance analysis for dependent variables have been reported in Table (3).

Table 3. Adjusted Mean, Standard Error, and Covariance Analysis for Dependent Variable

Variable	Test Group		Control Group		F	Covariance	
	Mean	Standard Error	Mean	Standard Error		P	Eta
Sensory seeking	58.456	0.95	48.544	0.95	47.790	0.000	0.888
Emotional reactions	45.115	0.573	37.885	0.573	69.956	0.000	0.921
Weak sensory records	74.876	1.794	64.124	1.794	15.768	0.007	0.724
Sensitivity to stimulation	69.223	2.041	56.443	2.041	17.224	0.006	0.742

The Table (3) shows that the values for the means of the Test Group are at a higher level than those of the Control Group. Moreover, the Eta value shows that about 89% of the variance of the variable “sensory seeking”, 92% of the variance of the variable “emotional reaction”, 72% of the variance of the variable “weak sensory records” and 74% of the variance of the variable “sensitivity to stimulation” have been taken into account for the group variable. So, such results indicate that the stimulation of touch and vestibular senses have been affective on the improvement of behavioral abnormalities resulting from the sensory processing dysfunction including sensory seeking, emotional reactions, weak sensory records, and sensitivity to stimulation.

Discussion

The results indicated that the stimulation of touch and vestibular senses is effective on the improvement of behavioral disorders resulting from sensory processing dysfunction in autistic children. Since the behaviors in question are, in fact, reactions leading to the enhancement of sensory events in autistic children, so they tend to seek for receiving further touch, movement, sight and hearing stimuli and for the purpose of coming across such high thresholds, they tend to make a lot of noise and do not keep quiet, they touch everything, manipulate or chew objects and persons, and in general, they show motor abnormalities (self-stimulation and masochism) and

impulsivity and are actually seeking for sensory inputs. Such a description is in conformity with the classification of the disorder “sensory seeking”. So, the most effective interference to be applied for autistic children is to integrate the required senses into their daily life program, the most important senses being basic senses (including touch, profoundness, and vestibular senses). Such an opinion is the basis of Ayres’s treatment approach who maintains that the improvement of low level performances of basic senses can improve the higher level functions (6). That is why such treatments have already been applied to autistic children. As an instance, Krisna *et al.* (2009) studied the effects of traditional massage therapy on the problematic behaviors and emotions of six autistic children of 4, 6 and 7 years old by making use of the Kanner Questionnaire and showed that massage therapy had a positive effect on their stereotype behaviors and emotions. Moreover, the results of a professional sensory integration treatment of 10 weeks on 5 autistic children indicated that 4 children had showed a decrease in their serotype behaviors. In line with such findings, the results of the present research also show that making use of touch and vestibular stimulations can lead to an improvement of behaviors resulting from sensory seeking abnormality in autistic children.

Furthermore, the research results have shown that the stimulation of touch and vestibular senses is

effective on the improvement of emotional reactions in autistic children because emotional reactions in autistic children consist of behavioral patterns that indicate the need for decreasing unexpected stimuli occurring along with the activities and since such children are not comfortable with their neurological thresholds, they try to get away from such events; for instance, they get angry or rebel emotionally when they come across a low threshold of surrounding noise or they are burdened with regulation disorders such as the emergence of domineering behavior, disobedience, avoiding from eye contacts, feeling of fear and anxiety, being obstinate, lack of interaction in playing with children of the same age, and resistance against change. So, in their treatment package, we should use a mix of familiar and new sensory stimulations to enable them to adapt themselves to new stimuli and to achieve comfort. Ayres believed that a large number of emotional behavior of autistic children resulted from the ineffectiveness of the vestibular corridor system on the meshed structures of such patients (9). So, if all stimulations are equally received by the brain in their unadjusted form, then the individual may reflect them through screaming, domineering, fearing, feeling anxiety and unbalanced eye movements (10). Therefore, doing vestibular and touch stimulations in accordance with autistic children's sensory needs may improve their emotional reactions. Watling and Deitz (10) have reported a considerable effectiveness of the application of Ayres's sensory integration procedure on the improvement of undesirable behaviors and social communication of 4 autistic children where the treatment have been provided both at home and in session therapies. In line with this finding, the results of the present research indicate that such kind of stimulations can lead to an improvement of emotional reactions.

According to Fisher, basic shortcomings with the reception, recording and organization of corridor-profoundness and touch senses as well as deficiencies with the integration of such senses in the central nervous system leads to deficiencies with one's perception and movement skills and abilities (11). Since most autistic children easily get bored and they do not have high degrees of tolerance, their fine motor skills are weak and when they are standing, they hold a specific physical position to keep their balance, and as they have problems with recording the stimuli of the abnormalities, so they seem to be uninterested and indifferent to any

relevant interactions; in essence, the behavioral description of their low level of tolerance, weak perception and inactivity is equivalent with their weak sensory records (National Society of Clinical Planning for Children). Therefore, an increase in the autistic children's reception of sensory information through condensed sensory stimulations can improve their performance, reactivity, and tolerance. Moreover, more likely different touch and vestibular sensory stimulations through the spinal cord and the nervous system are sent to higher centers of the brain and in the brain stem, they get into the meshed structure which functions as an integrating system of the brain, harmonizing and correcting the individual's muscular activities and physical movements in order to improve his mental and performance abilities.

Ayres has conducted a full-year research on 10 autistic children with an average age of 7.4 years old to study the impacts of touch and vestibular stimuli as a predictor of positive response to sensory integration procedures by such children (9). Ayres concluded that the best responses were in relation to touch defense, avoidance from movement, awareness and the feeling of insecurity. Haghgoo conducted a research on a sample of 30 subjects to study the effects of sensory stimulations on the treatment of autistic children and concluded that sensory stimulations of such children had increased their social, verbal and face interactions as well as their abilities for imagination and imitation Haghgoo also reported that there had been a direct positive connection between the disorder in the sensory integration and the emergence of symptoms of autism (12). The present research results have also shown that touch and vestibular sensory stimulations have led to the improvement of both "weak sensory records" and "sensitivity to stimulation" in autistic children.

Since autistic children's responses to the physical environment are abnormal and they have typically been assumed to have superficial sensory deficiency and since such children hardly complete and perform their duties and are rarely aware of their experiences due to the fact that their responses to all sensory stimuli are severe, and as such, their behavioral patterns are shaped around low neurological thresholds including such cases as absent-mindedness, carelessness, sensory sensitivity and oral sensory sensitivity (13), then, multi-sensory stimulations of sensory integration may increase their sensory processing in characterizing the status

of the stimulation, as well as recognizing and decreasing the process time, and may resultantly lead to the improvement of autistic children's ability of attention and the decrease of their sensory sensitivities. The same reasons may be at work for avoiding touch sense defense. Experiments on animals and human beings have already shown that a deep touch sense can be relaxing and may decrease one's nervous system's level of being stimulated and that it can lower down the metabolism, muscular tone, and heart beats and as such, it may lead to the improvement of one's sensory performances (14) . Moreover, as for sensory integration, it is typically mentioned that some behavioral abnormalities, including intolerance of smells and tastes which result from sensory input processing deficiency and lead to oral sense sensitivity may be treated and

improved through the application of the method introduced in the present paper(15) .

Concluding Remarks - Making use of sensory stimulations specially touch and vestibular sensory stimulations can be effective on an improvement of behavioral abnormalities of autistic children, a decrease in their sensitivities and increase in their levels of attention. Therefore, it is recommended to use such kinds of stimulation in planning for the treatment of a large variety of abnormalities with autistic children. As the ending point, the authors would like to express their deep gratitude for all the efforts made by the patients under study and their parents as well as all help and kindness received from the staff and the therapists of the schools in question who created a warm environment for our work.

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