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SENSORY INTEGRATION AND ACTIVITIES THAT PROMOTE SENSORY INTEGRATION IN CHILDREN WITH AUTISM SPECTRUM DISORDERS

Original scientific paper

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ABSTRACT

The aim of this review was to systematically identify, analyze, and summarize research involving interventions based on sensory integration and activities that promote sensory integration in children with ASD. Based on the selection criteria ten out of thirty studies were selected and described in terms of: a) participant characteristics, b) assessments used in the studies, c) intervention procedures, d) study goals, e) intervention outcomes and whether or not there was improvement in behavior or clinical conditions. The results of the analyzed studies indicate a remarkable heterogeneity profile of sensory function in children with ASD, which affect the applicability of different forms of treatment. Based on the results of these studies, we can conclude that treatments based on SI theory can reduce stereotypical, aggressive, auto-aggressive, irritable, and hyperactive behavior, as well as improve self-regulation of behavior.

***Keywords**: Autism, sensory integration, sensory disorders, therapy, auditory intervention training, sensory intervention therapy*

INTRODUCTION

Sensory integration therapy (SIT) or sensory processing therapy (SPT) and activities that promote sensory integration are widely used diagnosing and treating disabilities in children with Autism Spectrum Disorder (ASD). Treatments based on the theory of sensory integration that are most often used in working with people with ASD are sensory integration therapy (SIT), auditory integration training (AIT) and deep pressure therapy (DPT) (Green et al., 2006).

Sensory integration (SI) is a neurological process, also described as Sensory Processing (SP) that allows us to take information we receive from our five senses, organize it, and respond appropriately.

The development of the sensory system begins in the intrauterine period and continues throughout the life of the individual (Mamic, Fulgosi Masnjak, & Miller, 2010). Sensory system consists of seven areas of sensory modalities: auditory, visual, tactile, olfactory, gustatory, vestibular, and proprioceptive (Mamic & Fulgosi Masnjak, 2010). Interacting with others and with the environment relies on sensory information we receive through the sensory system (Van Dam, Paris, & Ernst, 2014). Although cortical structures responsible for receiving, processing, integrating, and interpreting sensory information are the same in all people, the way an individual experiences and responds to external sensa-

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tions varies from person to person (Sobocko & Zelenski, 2015). The basic capacities of sensory integration are genetically determined; the development of this complex process takes place through interaction with the environment and cerebral and bodily adaptation to external conditions, which is mutually conditioned by adaptive reactions (Macesic-Petrovic, 2014). A child, while interacting with its environment, both physical and social, acquires new and upgrades previous experiences. The quality of these experiences is significantly influenced by the quality of processing information (Bojanin, 2015).

The development of the individual is significantly influenced by the ability to integrate sensory stimuli as one of the key neurobehavioral processes (Fernández-Andrés, Pastor-Cerezuela, Sanz-Cervera & Tárraga-Mínguez, 2015). Most everyday human activities require multisensory information processing (Hainaut & Bolmont, 2013) that has a significant impact on the quality of the experience and behavior of the person (Boterberg & Warreyn, 2016). Typical perceptual experience is characterized by perceptual unity, which is reflected in multisensory integration. At the level of subjective experience this perception is a unique experience, regardless of the characteristics of integrated sensation. Studies have shown that often comes to the modulation process sensory information perception by a sensory perception of other modalities (Bayne, 2014). Adequate sensory integration enables accurate representation of external stimuli, which requires an appropriate orientation in the environment in which we live, adequate perception of the environment and, therefore, a coordinated reaction (Mamic et al., 2010; Panzeri, Harvey, Piasini, Latham, & Fellin, 2017).

If a person cannot ‘‘organize sensory information for use’’ (Ayres, 1972, p. 4) they can be described as having sensory integration disorder (SID) or sensory processing difficulties. SID or sensory processing difficulties include disorders of perception, modulation, integration and organization of sensory information and the characteristics of the sensory profile of a person with these difficulties are manifested in the adaptive behavior of the individual (Gal, Dyck, & Passmore, 2010).

According to the theory of sensory integration, sensory processing is the basis of adaptive behavior, learning and socio-cognitive functioning, so it is not surprising that difficulties in sensory processing are manifested in the behavioral, cognitive and social domain, as difficulties in (self) regulation of behavior, planning and motor activities (Jirikowic, Olson, & Kartin, 2008). Sensory processing difficulties significantly affect the sensory-motor, cognitive and social development of the child, and the effects are observed in a limited ability to function in daily life which affects the quality of life of an individual (Dunn, 1997).

In the DSM-5 classification of the American Psychiatric Association (APA, 2013), autism spectrum disorders (ASD) belong to the group of neurodevelopment disorders. This group of disorders is characterized by persistent deficits in social communication and social interactions, as well as persistence of stereotypical behavior, repetitive forms of behavior, interests, or activities (Fernández-Andrés et al., 2015). In addition to these basic characteristics, the latest edition of the classification includes the presence of sensory processing difficulties as a diagnostic criterion of ASD (Sanz-Cervera, Pastor-Cerezuela, Fernández-Andrés, & Tárraga-Mínguez, 2015). Although the first description of ASD includes difficulties in sensory processing, those in earlier classifications were not accepted as a diagnostic criterion, due to the scarcity of empirical evidence, as well as because the focus was on the cognitive and social deficits (Novakovic et al., 2015).

This is a review article of existing research involving interventions based on SIT and activities that promote sensory integration in children with ASD. The aim of this review is to determine if SIT and activities that promote sensory integration can be classified as a scientifically based intervention for children with ASD. Forgoing we examined the effectiveness of procedures and interventions conducted with the goal to enhance sensory integration of children with ASD and doing so we determined if SIT can be classified as a scientifically based intervention for children with ASD.

METHOD

The service of the Consortium of Libraries of Serbia for Unified Procurement (KOBSON), Google Scholar, SCIndeks, as well as the search engine ScienceDirect were used in the literature review. Literature was searched in both Serbian and English language. The following phrases were used as keywords in the search: sensory processing, sensory processing difficulties, sensory integration, sensory integration therapy, sensory development, and sensory dysfunctions, crossed with the following words: autism, autism spectrum disorders, developmental disorders, developmental disability.

After the initial search, 30 papers were analyzed based on their titles and keywords. Selection criteria henceforward was as follows: that the article dates from 2010 to 2020; that it is not a theoretical article or a review article; that the sample included subjects with ASD; that the topic focuses on the interventions and procedures of sensory integration and / or activities that can encourage sensory integration in children with ASD; that the paper presents activities that promote the sensory integration of children with ASD. Ten articles were selected for this review based on the selection criteria.

LITERATURE REVIEW RESULTS

For the purpose of this review ten papers were selected based on previously determined criteria. Table 1 summarizes: a) participant characteristics, b) assessments used in the studies, c) intervention procedures, d) study goals, e) intervention outcomes and whether or not there was improvement in behavior or clinical conditions.

Participants:
There were a total of 410 subjects in the ten presented studies, 319 (77, 80%) of the subjects were diagnosed with ASD, 39 (9, 51%) of them had ID, 11 (2, 68%) had Asperser's syndrome, 16 (3,90) were diagnosed with PDD-NOS and 25 (6,10) had other types of disabilities. As for gender the majority of the subjects were males 338 (82, 44%) and 72 (17,56%) were females. Participants ranged in age from 3 to 18 years. Overall, participants involved in these studies were mainly of elementary school age with autism and a large percentage also had moderate to profound ID.

***Assessments used*:**

Three studies used the Short Sensory Profile (SSP; Dunn, 1999) to confirm the presence of sensory processing issues prior to implementing SIT (Kashefimehr, et al., 2017) or AIT (Brockett, et al., 2014; Al-Ayadhi et al., 2018). SSP is a standardized assessment tool intended for children 3 to 10 years old. It's a 5 point Likert scale with 38 items that measure how the child responds to various sensory stimuli and is usually completed by primary caregivers. Scores are provided in seven categories (tactile sensitivity, taste/smell sensitivity, movement sensitivity, under responsive and seeks sensation, auditory filtering, low energy, and visual and/or auditory sensitivity) intended to identify how a child's nervous system regulates and processes sensory input.
The Sensory Processing Measure (SPM: Glennon, Miller-Kuhaneck, Henry, Parham, & Ecker, 2007) was used in two studies (Bagatell et al., 2010; Pfeiffer et al., 2011) to identify sensory processing issues and describe them. The assessment tool can be used by primary caregivers and teachers or clinicians. The SPM consists of 75 items (form for primary caregivers) and 62 items (classroom form completed by teachers). Scores are generated into eight standards that describe social participation, vision, hearing, touch, body awareness, balance and motion, planning, and total sensory system and children's sensory processing is classified as ''typical'', ''some problems'' or ''definite problems''.
The Childhood Autism Rating Scale (CARS) was used to measure the severity of autism in three of the analyzed studies (Al-Ayadhi et al., 2013; Al-Ayadhi et al., 2018; Wenix et al., 2019). CARS measures 14 dimensions such as interpersonal relationships, emotional responses, adaptation to environmental changes, visual responses, anxiety responses, non-verbal communication, and so on.
The higher the score the severe the condition is.
For example a total score above 30 points can be considered to have autism, whereas those with 30–36 points are divided into mild to moderate autism and those with a score above 36 points with more than 5 indicators achieving 3 or more points can be considered to have severe autism.
Three out of the ten studies used The Social Responsiveness Scale (SRS) to measure interpersonal behavior, communication, and stereotypical traits in autism (Pfeiffer et al. 2011; Al-Ayadhi et al., 2013; Al-Ayadhi et al., 2018). The SRS has five subscales a) social awareness, b) social cognition, c) social communication, d) social motivation, and e) autistic mannerisms.
The Autistic Behavior Check List (ABC List) (Lu et al. 2004) was used to determine if a child had autism in two studies (Brockett, et al., 2014; Wenix et al., 2019). This check list has 57 items and the final score is used for evaluation, the higher the score the likelihood of a subject to have autism is higher. For example if the total score is below 31 points, then the subject is considered not to have autism at all. But those with a total score of 53–66 points can be considered to have suspected autism, while if the total score is 67 points or more, then the subject can be considered to have autism.
Pfeiffer et al. (2011) used QNST–II (Mutti et al., 1998) to assess areas including praxis, dexterity, visual tracking, spatial orientation, tactile perception abilities, and motor skills. Vineland Adaptive Behavior Scales, 2nd Edition was used to measure adaptive behavior that assesses the domains of communication, daily living skills, socialization, and motor skills. And the Goal Attainment Scaling was used to determine intervention outcomes expressly relevant to individuals and their families. The goals focused on the three categories of sensory processing, motor skills, and social functioning.
In one study the Autism Treatment Evaluation Checklist (ATEC) was used to evaluate treatment efficiency in subjects with ASD (Ayadhi et al., 2013). This assessment tool is divided into four subscales labeled Speech/ Language/ Communication, Sociability, Sensory/Cognitive Awareness, and Health/ Physical/ Behavior. The subject is more impaired if the subscale and total scores are higher.

Citation	Participant characteristics	Assessment	Intervention/procedure	The purpose of the study	Results	There was improvement in which behaviour	The intervention did not improve the following behaviour
Al-Ayadhi et al. (2013)	Total subjects: 72 (M 70/F2) Dg.: ASD; Age: 3 to 17 yrs.	Childhood Autism Rating Scale (CARS), Social Responsiveness Scale (SRS), and the Autism Treatment Evaluation Checklist (ATEC).	Auditory integration training (AIT). 18 to 20 listening sessions, lasting for 30 minutes, over a 10- to 20-day period in most cases, and had a 1- or 2-day break after 5 days of listening. During the listening sessions, the child listened to processed music. Overall, the music was played at a moderately loud, but not uncomfortable, level.	The aim of the study was to determine the effectiveness of AIT in people with ASD.	Mixed. All subjects demonstrated improvement 3 and 6 months following the AIT. ASD subject showed 22% and 26% percentage improvement in SRS scoring 3 and 6 months respectively following the AIT intervention.	There were statistically significant changes in social awareness, social cognition, and social communication. Similar results were achieved with the ATEC checklist: ASD subjects showed 19.5% and 22.5% improvement 3 and 6 months following the AIT intervention. Those changes are due to statistically significant (P , 0.05) improvement in speech, communication and sociability only.	No improvement was registered in the domain of social motivation and stereotypical behaviour, as well as in the sensory and cognitive domain.
Al-Ayadhi et al. (2018)	Total: 15 subjects (M14/ F1); Dg::ASD Age: 3–12 years.	CARS, Social Responsiveness Scale (SRS - Constantine, Gruber, 2007) and the Short Sensory Profile (SSP)	AIT was performed over 2 weeks, for duration of 30 min, twice a day with a 3-h interval between sessions. The listener received 18–20 listening sessions. The intensity level (volume) during the AIT listening sessions did not exceed 80 dBA (low scale) and was set at much lower intensities depending on the individual's comfort level. Overall, the music was played at a moderately loud, but not uncomfortable level.	This study investigated the impact of AIT on transforming growth factor (TGF)-β1 and its effect on behavioural and social emotions in children with ASD.	Plasma levels of TGF-β1 significantly increased to 85% immediately after AIT (20.13 ± 12 ng/mL, $p < 0.05$), to 95% 1 month after AIT (21.2 ± 11 ng/mL, $p < 0.01$), and to 105%. 3 months after AIT (22.25 ± 16 ng/mL, $p < 0.01$) compared to before AIT (10.85 ± 8 ng/mL).	Results also revealed that behavioural rating scales CARS, SRS, and SSP improved in terms of symptom severity after AIT.	Not specified
Bagatell et al. (2010)	Total:6 boys with autism spectrum disorder (ASD), all in first grade	The sensory processing pattern of each participant was assessed using the Sensory Processing Measure that was scored by the teacher.	The procedure was divided into stages; all of them were set in the classroom. Phase A: Baseline lasted 5 days used to collect date during Circle time. Phase B: Intervention: occurred over 9 days during Circle time but children, teacher, and instructional aides sat on therapy ball chairs with a ring stabilizer. Phase C: Choice. During the final phase (5 days), the children were given the choice of sitting on a regular seating device (chair) or on a therapy ball chair.	The goal was to examine classroom participation—specifically, in-seat behaviour and engagement and social validity.	Of the six respondents one student with ASD showed the most significant progress after using the therapeutic sitting ball, also the higher degree of participation and better self-regulation of sitting behaviour after the application of therapeutic sitting balls.	The ball chair appeared to have a positive effect on in-seat behaviour for the child who had the most extreme vestibular–proprioceptive seeking behaviours.	The use of the therapy ball chair did not positively affect engagement.

Citation	Participant characteristics	Assessment	Intervention/procedure	The purpose of the study	Results	There was improvement in which behaviour	The intervention did not improve the following behaviour
Bestbier & Williams, (2017)	Total: 13 students; Gender: 2 girls and 13 boys;Gender: 2 girls and 13 boys; Dg.: 8 with ASD and 7 ID; Age: ranged from 7 yrs and 10mths to 18 yrs and 7mths	Pretest-posttest design was employed to evaluate the effects of deep pressure sessions on young people with ASD and severe intellectual disabilities. Visual analogue scale was to measure mood and activity of the young people by school staff.	Setting: quiet places with minimal distraction in the school. Three deep pressure techniques were used, by care and education staff that had been trained by an occupational therapist with a sensory integration qualification: brushing, massage, and squeezing. The sessions lasted between five and fifteen minutes, up to three times per day during school hours. The deep pressure was delivered over a period of three months on weekdays when the young people were in school.	This study was designed to provide information about the extent of variability of the immediate responses of young people with ASD and severe intellectual disability to deep pressure by providing regular access to deep pressure	Results mixed.Four of the young people showed benefits in all areas measured, two showed no benefits in any area, and further two showed benefits on three and two ratings each.	On the Calmness subscale results indicate improvement for 75% of the participants. On the Engaged subscale results indicate improvement for 62.5% of the participants. On the Responsively subscale results indicate improvement for 62.5% of the participants. On the Happy subscale results indicate improvement for 50% of the participants. On the Communicative subscale results indicate improvement for 62.5% of the participants.	On the Calmness subscale results did not indicate improvement for the 25% of the participants. On the Engaged subscale results did not indicate improvement for the 37.5% of the participants. On the Responsively subscale results did not indicate improvement for the 37.5% of the participants. On the Happy subscale results did not indicate improvement for 50% of the participants. On the Communicative subscale results did not indicate improvement for 37.5% of the participants.
Brockett, et al. (2014)	Total:54 children Gender: 45 males (83%) and 9 females (17%). Dg. 35 autism/ PDD-NOS, 7 speech/ language disorders, 6 sound sensitivity/ auditory processing disorders, 5 ADD, 4 SPD and 5 no diagnostic label Age: 3–10 years (M 6).	The SSP (Dunn, 1999) checklist which measures behavioral response to specific sensory stimuli that occur during daily life activities, such as (1) Tactile Sensitivity, (2) Taste/Smell Sensitivity, (3) Movement Sensitivity, (4) Under-Responsive/Seeks Sensation, (5) Auditory Filtering, (6) Low Energy/ Weak and (7) Visual/Auditory Sensitivity was completed by primary care givers. The ABC behavior rating scale was used to measure behavior such as irritability, stereotypic, lethargy, hyperactivity, inappropriate speech.	All children participate in a standard protocol of Berard AIT that consisted of two 30-minute sessions of listening each day for 10 consecutive days. With a three-hour break from the auditory stimulation between sessions. Music for Berard AIT is generally a variety of light rock, reggae, and jazz, selected specifically to assure that it contains a wide range of frequencies from 20 Hz to 20 kHz.	The purpose of this study was to determine if behaviors specifically related to sensory modulation showed positive changes following 10 days of Berard AIT.	Analysis of variance indicated that SSP total test scores and individual factor sections improved from pretest to post-test (P 0.01). Behavioral problems reduced on all five factors of the Aberrant Behavior Checklist (ABC) (P 0.01). Most changes occurred within one month of intervention and maintained at three and six months. Correlations among the ABC and SSP factors indicate that sensory modulation as measured by the SSP is a significant contributor to four of the behavioral factors measured by the ABC.	The children's results improved in the following domains: tactile sensitivity, taste/smell sensitivity, movement sensitivity, under-responsively, auditory filtering, low energy/weak, and visual/ auditory sensitivity. The results measured on ABC scale indicate improvement in following domains: irritability, lethargy, stereotypy, hyperactivity, inappropriate speech.	Not specified

Citation	Participant characteristics	Assessment	Intervention/procedure	The purpose of the study	Results	There was improvement in which behaviour	The intervention did not improve the following behaviour
Iwanaga et al. (2014)	Total:20 children; Gender: 18 males and 2 females. Dg. 9 autism and 11 Asperser's syndrome Average age 4.7 years.	JMAP (Tsuchida et al., 1989), a re-standardized version of the Miller Assessment for Preschoolers (MAP) for use with Japanese children was used to measure five major developmental indices: 1) Foundation Index; 2) Coordination Index; 3) Verbal Index; 4) Non-verbal Index; and 5) Complex Index. A trained practitioner administered the test individually before and after the treatment.	8 children received individual SIT and 12 children received group therapy (GT). 17 of the subjects were treated in Nagasaki Prefectural Medical Treatment and Education Centre. Twelve children of them received GT and five received SIT. Three children who received SIT were treated in the clinic at Nagasaki University. Durations of SIT and GT were between 8 to 10 months. SIT included the 10 key therapeutic strategies identified by Parham et al. (2007).	The aim was to examine the effectiveness of SIT on cognition, verbal, and sensory motor abilities in children with ASD.	Results mixed; For SIT group interventions before and after therapy there were significant gains for Total score ($p = 0.012$), Foundation Index score ($p = 0.035$), Coordination Index score ($p = 0.012$), Nonverbal Index score ($p = 0.018$), and Complex Index score ($p = 0.018$). Verbal Index score showcased no significant changes ($p = 0.401$). For the GT group therapy Total score showed a significant gain from before to after therapy ($p = 0.015$), Foundation Index score ($p = 0.138$), Coordination Index score ($p = 0.08$), Verbal Index score ($p = 0.075$), Non-verbal Index score ($p = 0.433$).	Improvement in both groups in the domain of fine and gross motor skills, oral motor and visual-motor abilities, nonverbal memory, sequencing, visualization, solving complex problems that require the engagement of certain cognitive and sensory-motor abilities.	Verbal abilities have not significantly improved.
Kashefimehr, et al. (2017)	Total: 35 children; Gender: 28 boys and 3 girls; DG. ASD Age: 3 to 8 years \	The Short Child Occupational Profile (SCOPE, Kielhofner, 2002) was used to compare the two groups in terms of the changes in their occupational performance and the Sensory Profile (SP, Dunn, 1999) was used to assess sensory problems. The study used a pre and post test design.	The children were divided into two groups intervention group ($n = 16$) receiving SIT and a control group ($n = 15$). SIT was described as a clinic-based intervention that uses play activities and sensory-enhanced interactions to elicit the child's adaptive responses. In this intervention, the therapist creates activities that encourage the child's participation and challenge his sensory processing and motor planning skills following the 10 key therapeutic strategies identified by Parham et al. (2007). Each participant in the intervention group received 24 SIT (two per week), each 45 min. in length with an additional 15 Min. devoted to parent education. No information was given about the control group.	This study examined the effect of SIT on different aspects of occupational performance in children with ASD.	Results showed that significant difference were observed in SCOPE domains in pre intervention data but a significant difference was observed between the two groups in terms of the sensory seeking, sensory sensitivity, and behavioral outcomes ($p < .05$). A significantly greater improvement was observed in the intervention group in all domains of SCOPE including volition, habituation, communication and interaction skills, process skills, motor skills, and environment of occupational performance and also in the total score of the child ($p < 0.001$). Of the 35 ASD children participating in the study, 31 (88.6%) showed difference in sensory profile according to SP.	The intervention group showed significantly greater improvement in all the SCOPE domains, as well as in some of the SP domains	There was not improvement on the SP scale for the "emotional reactions" and "emotional/social responses" domains, ($p < .05$).

Citation	Participant characteristics	Assessment	Intervention/procedure	The purpose of the study	Results	There was improvement in which behaviour	The intervention did not improve the following behaviour
Pfeiffer et al. (2011)	Type of sample: convenient. Total: 37 children; Gender:32 males and 5 females, Dg.: 21 had autism and 16 with PDD-NOS. Ages between 6 and 12 (mean [M] age 5 8.8) .	All assessments were used as a pre and post test and were carried out by parents and clinicians, who were not aware of the group assessment. Sensory Processing Measure was used to measure sensory processing disorders. QNST–II (Mutti et al., 1998) was used to assess areas including praxis, dexterity, visual tracking, spatial orientation, tactile perception abilities, and motor skills.Social Responsiveness Scale was used to measure social impairments. Goal Attainment Scaling was used to determine intervention outcomes expressly relevant to individuals and their families. The goals focused on the three categories of sensory processing, motor skills, and social functioning. Vineland Adaptive Behavior Scales, 2nd Edition was used to measure adaptive behaviors that assess the domains of communication, daily living skills, socialization, and motor skills.	Two interventions SIT and fine motor intervention (FMT). Participants were randomly assigned 20 undergone SIT and 17 FMT intervention- control group. Both interventions consisted of 18 treatment interventions of 45 min each over a 6-wk period, SIT included the 10 key therapeutic strategies identified by Parham et al. (2007). FMT focused on three main activity areas: constructional, drawing and writing, and FM crafts.	Was to address the question of effectiveness of SI interventions in children with ASD.	Results were mixed. Both SIT and FMT groups had significant improvements toward goals on the GAS, but SIT demonstrated more significant improvement than the FM group in the attainment of goals as rated by parents ($p < .05$,) and teachers ($p < .01$).	Improvements were registered in significantly fewer autistic mannerisms in SIT group than in FMT group.	In both groups no significant differences were found processing standardized scores.
Thompson (2011)	Sample type: random. Total: 50 participants, Gender: 26 female students and 24 male students Dg.: 10 of them had autism, 32 intellectual disabilities and 8 children with multiple disabilities. Age: from 6 to 17.	The authors created an observation system to measure sustained focus.	Observations were conducted by trained observers stationed within secluded locations in the regular classrooms and multi-sensory centre. Students were observed individually within three types of environments and during three time periods: (1) initial observations was conducted within the regular classroom before treatment; (2) during the multi-sensory intervention; and (3) after the multi-sensory intervention in the classroom.	Was to examine the observed impact of multi-sensory experiences on the sustained focus of students with special needs.	Generally results were positive, the ability to maintain attention in learning conditions (during class) increased by 14%, while the manifestation of auto-aggressive behavior decreased by 98%. Also, the feeling of happiness, relaxation and the level of participation in the class increased significantly after the treatment in all respondents.	Not specified	Not specified

Citation	Participant characteristics	Assessment	Intervention/procedure	The purpose of the study	Results	There was improvement in which behaviour	The intervention did not improve the following behaviour
Wenix et al. (2019)	Sample type; convenient. Total:108 participants; Gender:88 male and 15 Dg. autism The participants were divided into group A and B. 43 male patients and 7 female patients with an average age of 6.17±2.44 were included in group A. 45 male patients and 8 female patients with an average age of 6.18±2.94 were included in group	CARS scale was used to measure interpersonal relationships, emotional responses, adaptation to environmental changes, visual responses, anxiety responses, non-verbal communication, and so on. Autistic Behavior Check List (ABC List) (Lu et al. 2004) was used to determine if a child had autism.	Participants were randomly divided into group A (SIT + routine treatment group) and group B (routine treatment group), each group had 54 members. Evaluation was carried out before and after the experiment, and the scales were filled in under the guidance of professionals. SIT method uses games such as slides, tossing, leaping, balance beam, and sling to train children's balance, communication, and brain integration functions.	The aim was to examine the joint effect of SIT and exercise intervention on the behaviors and quality of life of children with autism.	Results were positive but not conclusive. For group A, the marked effective rate was 55.56%, the effective rate was 30.56% and the total effective rate was 86.11%. For group B, the marked effective rate was 17.95%, the effective rate was 46.15%, and the total effective rate was 64.10%. Significant differences in the CARS scores of the two groups before and after the treatment ($P<0.05$). Moreover, statistically significant differences were observed in the ABC scores of the two groups before and after the treatment ($P<0.05$).	The sensory, language, communication, self-care, and physical exercise ability of the experiment group significantly improved after the intervention period. The difference with the control group after the intervention is statistically significant ($P<0.01$). ABC score of the experiment group has exhibited significantly lower score than before the intervention. However, a significant decline was observed in the ABC score of the control group. Further differential analysis suggests that the decline in the ABC score of the control group is significantly lower than that of the experiment group.	Not specified

***Intervention procedure*:**

Five of the ten studies presented in this paper focused on examining the effects of sensory integration therapy on cognition, verbal and sensorimotor abilities (Iwanaga et al., 2014), various aspects of occupational performance (Kashefimehr, et al., 2017), on the sustained focus (Thompson, 2011), behavior and quality of life of children with ASD (Wenix et al., 2019; Pfeiffer et al., 2011). Three of these studies included 10 key therapeutic strategies identified by Parham et al. (2007) (Iwanaga et al., 2014; Kashefimehr, et al., 2017; Pfeiffer et al., 2011), while the authors of the remaining two studies did not specify the sensory integration methods they applied (Thompson, 2011; Wenix et al., 2019).

Three studies were conducted to determine the effectiveness of auditory integration training in children with ASD (Al-Ayadhi et al., 2013) and the effects of this training on the behavior and social and emotional development of children with ASD (Al-Ayadhi et al. 2018). One of these studies focused on the impact of auditory integration training on behaviors directly related to sensory modulation problems in children with ASD (Brockett, et al., 2014).

One study involved alternative seating on therapy ball chairs in order to improve classroom participation, more specifically on in-seat behavior and engagement and social validity (Bagatell et al., 2010).

Finally, deep pressure therapy was used in one study to examine the effects of this therapy on the responsiveness of children with ASD and deep ID (Bestbier & Williams, 2017).

Eight studies conducted pre- and post-intervention evaluation (Al-Ayadhi et al., 2013; Al-Ayadhi et al., 2018; Bagatell et al., 2010; Bestbier & Williams, 2017; Iwanaga et al., 2014; Kashefimehr, et al., 2017; Pfeiffer et al., 2011; Wenix et al., 2019).

***Results/ improvements in behavior*:**

The results of the presented studies, focused on examining the effects of sensory integration therapy, indicate a significant positive impact of this type of intervention. After SI therapy progress has been noted in various domains: motor skills (Kashefimehr et al., 2017) - fine and gross motor skills, oral motor and visual-motor abilities (Iwanaga et al., 2014; Pfeiffer et al., 2011); sensory processing (Pfeiffer et al., 2011) nonverbal memory, sequencing, visualization, solving complex problems that require the engagement of certain cognitive and sensory-motor abilities (Iwanaga et al., 2014), adaptive behavior, social functioning (Pfeiffer et al., 2011) communication and interaction skills, environment of occupational performance (Kashefimehr et al., 2017), attention (Thompson, 2011).

Results show increase in the ability to maintain attention in learning conditions by 14%, and 98% decrease in auto-aggressive behavior in children with ASD after SIT (Thompson, 2011). Also, there is a noticeable difference in pre- and post-treatment scores on CARS and ABC which indicates a decline in autism specific behavior (Wenix et al., 2019). Positive changes in the sensory profile of children with ASD after SIT are also noticeable (Kashefimehr et al., 2017). On the other hand, no significant improvement was registered in verbal abilities (Iwanaga et al., 2014) and in the emotional domain - emotional reactions and emotional/social responses (Kashefimehr et al., 2017).

In the case of auditory integration training, pre- and post-evaluation results indicate improvement in social awareness, social cognition, and social communication (Al-Ayadhi et al., 2013), as well as improved scores on CARS, SRS, SSP, and ABC which indicate decline in condition severity and improvement in adaptive behavior after AIT (Al-Ayadhi et al., 2018; Brockett, et al., 2014). Changes in the sensory profile are reflected in the following domains: tactile sensitivity, taste/smell sensitivity, movement sensitivity, under-responsively, auditory filtering, low energy/weak, and visual/auditory sensitivity (Brockett, et al., 2014). On the other hand, positive behavioral changes are registered in the following domains: irritability, lethargy, stereotypy, hyperactivity, inappropriate speech. The results showed that most changes occurred within one month of intervention and maintained at three and six months (Al-Ayadhi et al., 2013; Al-Ayadhi et al., 2018; Brockett, et al., 2014). No improvement was registered in the domain of social motivation and stereotypical behavior, as well as in sensory and cognitive domain (Al-Ayadhi et al., 2013).

One study used therapeutic ball chairs to examine the effects of an alternative form of sitting on participation of student with ASD. The results of this study indicate that children with vestibular–proprioceptive seeking behaviors have benefited the most from this type of sitting. Significant progress is noticed in self-regulation of sitting behavior and participation in learning activities (Bagatell et al., 2010).

The use of deep pressure techniques (brushing, massage, and squeezing) has been shown to increase calmness (75%), engagement with activities (62.5%), responsiveness to instructions or other stimuli in the environment (62.5%), happiness (50%) and communicativeness (62.5%) in students with ASD and severe ID (Brockett, et al., 2014). However, the results of this research are mixed, maybe due to the fact that all participants received a different number of interventions on a weekly basis.

Based on the ten reviewed studies we can conclude that in people with ASD the most common difficulties are sensory processing of auditory stimuli and that sensory profiles are extremely heterogeneous. Because of this heterogeneous of sensory profiles and the lack of same methods used for SIT interventions we cannot conclude that this form of therapy is scientifically based.

CONCLUSIONS

The results of the analyzed studies indicate a remarkable heterogeneity profile of sensory function in children with ASD, which affect the applicability of different forms of treatment. Treatments based on the theory of SI are aimed at reducing or eliminating the difficulties of SI, which stimulates the cognitive and social development of the child with ASD, and thus affects the educational process and educational inclusion. Most of the research presented in this paper focuses on the influence of different forms of treatment on different domains of behavior of a child with ASD. Based on the results of these studies, we can conclude that treatments based on SI theory can reduce stereotypical, aggressive, auto-aggressive, irritable and hyperactive behavior, as well as improve self-regulation of behavior. The significance of these changes in the school environment is reflected in the increased possibility of active participation of children with ASD and the reduction of social distance of peers and other persons towards children with ASD, which supports the process of educational and social inclusion.

All research presented in this paper focuses on the effects of SI treatment on the functioning of children with ASD. The obtained findings indicate a positive influence of SIT, AIT and DPT on certain domains of functioning of children with ASD. The variability of the effects of these treatments in children with different sensory disorders indicates the need to create individualized treatment programs and combine different methods and techniques to encourage SI to provide adequate treatment tailored to the specific difficulties and abilities of each individual child. By hindering the daily functioning of a child with ASD, SI difficulties limit the possibility of participation of students with ASD in school activities, can lead to the creation and increase of social distance towards these students, hinder the process of adopting materials and, thus, require significant adjustments of curriculum and methods. Reducing or eliminating sensory difficulties has a positive impact on cognitive and social development, as well as on student's behavior, which conditions the better functioning of the individual with ASD both in the school environment and in the community. Therefore, it is necessary to conduct a more detailed analysis of sensory profiles of students with ASD, creating adequate instruments for assessment and monitoring, as well as examining the effectiveness of different SI treatments depending on the sensory difficulties of students with ASD. Ethnological aspects, typical for the environment of the child, can be included in therapeutically processes, such as movement, dance and music background in sensor-motor performance of the child.

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