The Effectiveness of Sensory Integration Therapy for Children with Asperger's Syndrome and Pervasive Developmental Disorder-Not Otherwise Specified: A Case Control Study

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Keywords: Autism Spectrum Disorders, Asperger's Syndrome, Pervasive Development Disorder NOS, Sensory Integration, Sensory Profile, BOT-2.

Abstract: Asperger's syndrome (AS) and Pervasive Development Disorder-NOS (PDD-NOS) challenge clinicians to seek effective interventions. This study aimed to determine if sensory integration (SI) therapy has an effect on any specific sensory motor deficits. The study used a pretest-posttest design. The intervention was SI therapy twice weekly for 10 weeks. Subjects were 9 AS and 8 PDD-NOS children. The assessment tools Sensory Profile and The Bruininks-Oseretsky Test of Motor Proficiency Second Edition (BOT-2) were performed at start, 5 weeks and after 10 weeks of intervention. Tests results were analyzed in SPSS v22 using ANOVA. Sensory seeking improved significantly ($p<.05$). ($p<.05$) on pretest-posttest and midtest- posttest. Auditory processing, modulation of movement affecting activity level, modulation of visual input affecting emotional responses and activity level ($p<.05$) of the Sensory Profile were significant. Post hoc analysis revealed significance in auditory processing from pretest to posttest ($p<.05$). ANOVA analysis approached significance on fine motor and perceptual skills ($p=.08$), multisensory processing ($p=.08$) and modulation related to body position and movement ($p=.08$). Significant difference ($p<.05$) was seen on the balance subtest, the running speed and agility subtest approached significance ($p=.07$). This study indicates that SI therapy is effective in some specific sensory deficits AS and PDD-NOS.

1 INTRODUCTION

Autism Spectrum Disorders (ASD) include Asperger's Syndrome (AS) and Pervasive-NOS Development Disorders (PDD-NOS), which are challenging topics among clinicians (American Psychiatric Association, 2013). This study relies on the assumption that the sensory and motor symptoms in children with AS and PDD-NOS are the results of abnormalities within the nervous system. It is also based on the Sensory Integration (SI) theory which provides a framework for understanding sensory processing dysfunction and the SI treatment approach which is described as preparing the body for purposeful interaction with the environment. Developmental abnormalities and an altered inferior olive in the brainstem have been identified in children with autism (Schaff et al, 2007). Auditory brainstem response abnormalities, including Prolonged intervals and abnormal individual waves, have also been noted, which may result in characteristics associated with autism and AS (Davidson and Williams, 2000). A study done by Minshew (2004) compared dynamic posturography results from children and adult subjects with autism to an effect cluster. The subjects with autism were noted to have delayed postural stability development and an underdeveloped postural control system. This suggested that there was basal ganglia involvement consistent with an increased caudate volume (Nicholas et al, 2008).

Nicholas and colleagues (2008) reported that 62% of the cases of ASDs, including children with AS, PDD-NOS and autism, in South Carolina have impaired motor skills (Schaff and Nightlinger, 2007). Within the diagnostic criteria of the DSM-V, motor delays and clumsiness are listed as associated

Sahid, M., Pratiwi, A. and Haryadi, R.
The Effectiveness of Sensory Integration Therapy for Children with Asperger's Syndrome and Pervasive Developmental Disorder-Not Otherwise Specified: A Case Control Study.
DOI: 10.5220/0009089302700280
In *Proceedings of the 11th National Congress and the 18th Annual Scientific Meeting of Indonesian Physical Medicine and Rehabilitation Association (KONAS XI and PIT XVIII PERDOSRI 2019)*, pages 270-280
ISBN: 978-989-758-409-1

features that are often present in children with AS (American Psychiatric Association, 2013). Children with AS have also been noted to have delayed motor milestones, poor posture, low muscle tone, decreased awareness and control of the body, decreased arm swing, stiff gait, poor rhythm and timing, stiff and clumsy movement patterns, a tendency to break things, difficulty catching and throwing, and poor handwriting (Klin, 2003). Khouzam, El-Gabalawi, Pirwani and Priest (2004) suggest that motor delays may be one of the first features recognized in young children, with the more typical AS symptoms presenting later (Khouzam et al, 2004).

Therefore, in order to contribute to an understanding about the sensory processing and motor skills of children with AS and related PDDs, and to assess the effectiveness of SI treatment, an intervention program based on the theories of SI was implemented for children with AS and PDD-NOS. The aims of this study were to demonstrate the extent of sensory and motor skills in children with AS and PDD-NOS and additionally determine if SI therapy has benefit in improving any specific deficits that were known in this cluster.

2 METHODS

2.1 Setting

The evaluation and intervention of the participants of this study took place in an occupational therapy center setting which contained the equipment necessary to provide SI therapy.

2.2 Participants

Inclusion criteria: At the time of the study, participants were required to be 5 to 9 years old, with a diagnosis of AS or PDD-NOS,. Since SI treatment relies on the presence of SI deficits, an additional inclusion criterion was that participants had SI deficits as determined by initial testing done by the researcher. Therefore, only children with SI deficits based on initial testing for the study were eligible to participate in the intervention phase of the research. Children receiving other therapy that utilized an SI approach were excluded.

Based on an autism to AS ratio of 5:1, it was conservatively estimated that approximately 37 children with a diagnosis of AS, were between the ages of 4 and 11 years (Fombonne, 2003). Since not all children with AS or PDD-NOS receive services, and diagnosis may be delayed beyond age 11, it was recognized that this was likely a low estimate of the number of children with AS. As we estimated that the number of potential subjects was relatively small, all potential participants who met the inclusion criteria, and agreed to participate by completing consent and assent forms, were enrolled in the study. During the recruitment period, we decided to include children with PDD-NOS, since obtaining study participants who met all study criteria for AS was difficult. A goal of at least 10 subjects was set, based on the power described previously and taking into account the possibility of attrition.

2.3 Human Subject Protection

Information collected for study purposes including the child's test scores and other private information, was recorded on the score forms in such a way that both the parents' and their child's identities remained confidential. Since the researcher needed to formulate a treatment plan for each child based on his or her test results, the researcher needed to know the child's name. Since both the researcher and another therapist conducted the testing during various phases of the research, the child's first name only was used during test sessions. The other therapist who administered some of the test procedures was asked to leave identifying information forms blank, so that code numbers could be entered by the researcher in order to maintain confidentiality. Once test forms were returned to the researcher, a code number was assigned to that child. With respect to dispersion of study information, any information regarding this study is and will be reported so that there is no way that the child can be identified. All forms have and will continue to be stored in a locked file cabinet in the office of the researcher for seven years, after which time those will be destroyed.

2.4 Study Design

This research was a preliminary study utilized a pre-test post-test design with a delayed treatment approach. At the initiation of the study, pretesting was conducted using the Sensory Profile and the BOT-2. To allow subjects to act as their own control, a 5-week baseline phase, in which no intervention was provided, took place prior to the start of SI therapy. Sensory integration therapy was provided for 10 weeks. Therapy sessions took place two days per week, for 45-60 minute sessions. Post-

testing occurred following the 10 week intervention period, and all of the testing procedures that were administered in the mid-testing phase were repeated.

2.5 Instrumentation

The Sensory Profile. The Sensory Profile is a parent completed questionnaire, which assesses the child's sensory processing and sensory modulation. It helps to determine areas of sensory processing deficits that may contribute to problems in completing daily life activities. It was given to the parents to complete at the start of the study, 5 weeks into the study, and at the end of treatment (Dunn, 2014).

The test is made up of three sections. The first section assesses the child's ability to process sensory information and is broken down by sensory systems which include: auditory, visual, vestibular, touch, multisensory and oral. The second section is used to assess the child's ability to modulate more than one type of sensory input at a time. The final section assesses behavioral and emotional responses. Results from the questionnaire provided information on the child's sensory seeking behaviors, emotional reactivity, low endurance or tone, oral sensory sensitivity and inattention or distractibility, as well as the presence of poor registration, sensory sensitivity, sedentary behaviors and fine motor and perceptual abilities (Dunn et al, 2002).

Internal consistency measures for the Sensory Profile ranged from .47-.91, and standard errors of measurement have been reported to be between 1.0 and 2.8, suggesting parental scores are similar to true scores (Dunn et al, 2002).

2.5.1 The Bruininks-Oseretsky Test of Motor Proficiency, Second Edition.

The BOT-2 was administered to the children at the beginning of the study, five weeks into the study, and at the end of the intervention phase. It measures the gross and fine motor performance of individuals, ages 4 to 21 years. The test is broken down into four composites, each with two subtests. The Fine Manual Control composite examines fine motor precision and integration. The Manual Coordination composite assesses manual dexterity and upper-limb coordination. A 3rd composite: Body coordination, assesses bilateral coordination and balance. Finally, running speed and agility and strength are assessed in the Strength and Agility composite. The scores from these subtests are added up to determine a Total Motor Composite Score which can be used to determine percentile ranks (Bruininks and Brett, 2010).

Internal consistency reliability has been obtained using Pearson correlations for subtests and a stratified alpha method for composite scores, and has been reported to range from moderate to excellent with subtest and composite correlation coefficients ranging from .60-.97. Test-retest reliability has been established based on a time frame of 7 to 42 days, with Pearson correlation coefficients averaging .78 (subtest) and .83 (composite) for children ages four to seven years,
.76 (subtest) and .83 (composite) for children ages 8-12, and .69 (subtest) and .77 (composite) for children 13-21 years of age. Interrater reliability Pearson correlation coefficients range from .86 to
.99 for all of the BOT-2 subtests and composites. A BOT-2 test kit is required to administer the test in the standardized manner, and test completion takes approximately one hour (Bruininks and Brett, 2005).

2.6 Data Analysis

All information was recorded and analyzed in SPSS version 22. To analyzed if children with AS and PDD-NOS demonstrate improvements in sensory processing or motor skills following SI intervention, scores for the Sensory Profile and BOT-2 were analyzed using repeated measures analysis of variance (ANOVA) in order to compare changes within individual participant scores across test sessions. A p value of less than .05 was interpreted to be significant. Post hoc testing using pairwise comparisons was performed to determine whether improvements were related to intervention. If significant differences were evident from pretest to posttest, or from midtest to posttest that were not present from pretest to midtest, the hypotheses that sensory processing or motor skills can improve following SI therapy could be accepted.

The researcher conducted all of the testing during the pretest and midtest phases of the study. In order to prevent researcher bias, a second examiner conducted the posttesting for each child who completed the intervention phase. This second examiner was trained and certified to administer the tests, and was blind to the purposes of the study.

Interrater reliability testing was completed for one child during the post-testing phase. The child was selected based on convenience with scheduling, and the posttesting phase was selected for reliability testing in order to prevent bias by the second examiner.

3 RESULTS

Initial contact was created with the parents of 25 children. From this cluster, 7 subjects declined participation. The primary reasons were inability to comply to the schedule, and the wish to find specific programs such as day or social programs. One person participated in a different AS study. The remaining 17 children enrolled in the study, 9 with AS and 8 PDD-NOS. 10 out of the 17 participants were male, age range 55 to 109 months, with a mean age of 80.9 months (6.6 years). Finally 12 participants completed the study because 5 participants were lost to follow up.

The result of Sensory Profile showed that most of 17 participants had sensory problems. Table 1 identifies the percentages of children reported as being definitely different from typically developing children.

Table 1: Summary of Mean Scores and Repeated Measures ANOVA for Sensory Profile.

Subtest	AS (N9)	PDD NOS (N8)
Auditory Processing	9 = 100%	7 = 88%
Visual Processing	6 = 67%	7 = 88%
Vestibular Processing	9 = 100%	8 = 100%
Touch Processing	9 = 100%	7 = 88%
Multisensory Processing	8 = 89%	7 = 88%
Oral Sensory Processing	7 = 78%	7 = 88%
Sensory Processing Related to Endurance/Tone	6 = 75%[a]	5 = 63%
Modulation Related to Body Position and Movement	6 = 67%	6 = 75%
Modulation of Movement Affecting Activity Level	9 = 100%	7 = 88%
Modulation of Sensory Input Affecting Emotional Responses	9 = 100%	8 = 100%
Modulation of Visual Input Affecting Emotional Responses and Activity Level	9 = 100%	8 = 100%
Emotional/Social Responses	9 = 100%	8 = 100%

Table 2: Summary of Mean Scores and Repeated Measures ANOVA for Sensory Profile.

	M (SD)	M (SD)	M (SD)			Effect Size	Pretest-Midtest	Pretest-Posttest	Midtest-Postest
Auditory Processing (sound)	21,67 (5,47)	22, 18 (5,08)	25,80 (6,40)	7,41*	0,01	0,47	0,08	0,00	0,21
Visual Processing (vision)	27,07 (6,55)	27,82 (5,00)	29,65 (7,38)	0,98	0,44	0,27	0,58	0,26	0,49
Vestibular Processing (movement)	38,66 (6,96)	41,33 (5,36)	42,81 (6,11)	3,43	0,05	0,28	0,03	0,10	0,42
Touch Processing	57,30 (9,61)	60,30 (9,54)	66,66 (9,87)	10,40*	0,00	0,65	0,02	0,01	0,05
Multisensory Processing (multiple, simultaneous sensory experiences)	20,30 (1,21)	22,52 (2,59)	25,31 (4,52)	3,20	0,09	0,75	0,86	0,17	0,06
Oral Sensory Processing (mouth)	38,17 (11,86)	36,68 (15,28)	40,18 (11,03)	0,92	0,41	0,18	0,77	0,20	0,36
Sensory Processing Related to Endurance/Tone	26,66 (9,40)	27,50 (9,90)	32,00 (7,87)	0,61	0,58	0,27	0,66	0,43	0,47
Modulation Related to Body Position and Movement	34,65 (4,03)	35,31 (5,82)	38,50 (8,06)	3,23	0,07	0,46	0,11	0,08	0,22
Modulation of Movement Affecting Activity Level	20,00 (2,43)	19,50 (3,15)	23,01 (2,19)	4,31*	0,04	1,28	0,61	0,08	0,05
Modulation of Sensory Input Affecting Emotional Responses	11, 01 (2,53)	12,02 (2,10)	12,65 (2,34)	0,61	0,57	0,33	0,32	0,37	0,73
Modulation of Visual Input Affecting Emotional Responses and Activity Level	11,00 (0,63)	11,15 (1,73)	12,52 (1,86)	4,74*	0,40	0,73	0,72	0,06	0,06
Emotional/Social Responses (inappropriate behaviors)	48,10 (8,09)	50,52 (3,94)	55,52 (5,21)	1,80	0,22	1,06	0,60	0,21	0,21
Subtest	Pretest	Midtest	Post test	F	P	Post-Hoc Test			

Table 3: Summary of Mean Scores and Repeated Measures ANOVA for Sensory Profile.

Subtest	Pretest	Midtest	Post test	F	P	Post-Hoc Test			
						Effect Size	Pretest-Midtest	Pretest-Posttest	Midtest-Postest
	M (SD)	M (SD)	M (SD)						
Sensory Seeking	49,69 (3,63)	51, 03 (5,81)	60,50 (12,82)	6,61*	0,02	0,95	0,50	0,05	0,03
Emotionally Reactive	40,07 (6,52)	41,82 (4,56)	46,83 (5,38)	2,23	0,17	0,87	0,33	0,16	0,29
Low Endurance/Tone	28,66 (9,41)	29,53 (9,92)	32,00 (7,81)	0,63	0,58	0,28	0,68	0,40	0,46
Oral Sensory Sensitivity	28,30 (9,31)	26,03 (12,54)	28,66 (9,37)	1,08	0,30	0,25	0,42	0,78	0,23
Inattention/Distractibility	15,78 (3,06)	19,02 (3,09)	20,81 (5,82)	7,40	0,04	0,40	0,02	0,01	0,33
Poor Registration	28,07 (3,53)	28,01 (2,98)	29,68 (5,25)	0,88	0,46	0,38	1,01	0,42	0,23
Sensory Sensitivity	15,16 (4,54)	15,01 (4,23)	15,80 (3,73)	0,71	0,53	0,27	0,76	0,39	0,47
Sedentary	13,07 (4,40)	12, 51 (4,04)	14,30 (2,87)	1,60	0,27	0,54	0,59	0,23	0,24
Fine Motor/Perceptual	7,65 (2,73)	8,81 (2,16)	9,20 (1,96)	3,53	0,07	0,17	0,21	0,05	0,32

Sensory Profile subtest were analyzed to determine if significant differences were evident following Sensory Integration therapy. The Sensory Seeking factor improved significantly ($p<.05$). Post hoc analysis identified significant ($p<.05$) changes between pretest and posttest, and also between midtest and posttest. This means that parents reported less frequent attempts by their child to seek out and provide himself or herself with additional sensory input. Three sections of the Sensory Profile, also showed significant improvement following intervention (table 3). These include Auditory Processing, Modulation of Movement Affecting Activity Level and Modulation of Visual Input Affecting Emotional Responses and Activity Level ($p<.05$). Post hoc analysis revealed significant improvements in Auditory Processing from pretest to posttest ($p<.05$). Modulation of Visual Input Affecting Emotional Responses and Activity Level assesses a child's ability to use visual input appropriately during personal interactions including the ability to make eye contact, and the ability to recognize but not visually obsess about the actions of others. In this subtest, children demonstrated significant improvement from pretest to posttest ($p<.05$). Significant differences were also identified for Modulation of Movement Affecting Activity Level. For this subtest however, when post hoc analyses were completed, the results did not indicate significant differences. Repeated measures ANOVA approached significance on four other subtests of the Sensory Profile (table 2). These tests included Fine Motor and Perceptual Skills ($p=.08$), Multisensory Processing ($p=.08$) and Modulation Related to Body Position and Movement ($p=.08$). An improvement in Fine Motor and Perceptual skills reflects improvements in a child's ability to perform fine motor skills such as writing and drawing. An improvement in Multisensory Processing points to improvements in a child's ability to process information that is entering the body from more than one sensory system. Finally, the results on the Modulation Related to Body Position and Movement subtest suggest that following the 10-week intervention phase, the children were better able to control the amount of movement in which they engaged. A 10 week intervention phase was effective in improving some areas of sensory processing, some motor skills and some behaviors.

Table 4 showed that most of 17 participants had impaired motor skills. Percentages of 4 aspect in motor skills problems. A 10 weeks intervention phase was effective in improving certain areas of sensory processing, motor skills

and behaviors. The results from this study provide preliminary evidence to support the use of SI therapy in children with AS and PDD- NOS (table 5). The results indicated that the participants demonstrated significant improvements (p<.05) on the Balance subtest, with significant changes occurring from pretest to posttest. Additionally, significance was approached on the Running Speed and Agility subtest (p=.07) (table 5). This means that children demonstrated more success to perform complex motor skills following the intervention. Composite scores were not significantly impacted following intervention.

Therefore, since significant or nearly significant improvements were noted for two subtests of the BOT-2 during posttest that were not present for pretest or midtest, it appears that certain areas of motor function were improved following SI therapy. It should also be note that the participants did not demonstrate significant improvements in Fine Motor Precision, Fine Motor Integration, Manual Dexterity, Upper-Limb Coordination, Bilateral Coordination or Strength, which may suggest that some types of motor skills, such as balance, running and agility may respond better to ten weeks of SI therapy than other types of motor skills.

Table 4: Percentage of part cipants whose BOT-2 composite scores fell at or below the 18th percentile compared to normative data indicating impaired motor skills.

BOT-2 Composite Scores	AS (N=9)	PDD NOS (N=8)
Fine Manual Control (Fine Motor Precision and Fine Motor Integration)	6 = 67%	6 = 75%
Manual Coordination (Manual Dexterity and Upper-Limb Coordination)	6 = 67%	4 = 50%
Body Coordination (Bilateral Coordination and Balance)	9 = 100%	7 = 88%
Strength and Agility (Running Speed and Agility and Strength)	5 = 56%	4 = 50%

Table 5: Summary of Mean Scores and Repeated Measures ANOVA for BOT-2.

Subtest	*Pre test* M (SD)	*Mid test* M (SD)	*Post test* M (SD)	F	P	*Effect* Size	*Pre test-* Mid test	*Pre test-* Post test	*Midtest- Post test*
Fine Motor Precision	11,67 (5,79)	13, 18 (6,23)	*9,16 (5,98)*	*2,50*	*0,10*	*-0,63*	*0,16*	*0,24*	*0,15*
Fine Motor Integration	13,93 (6,13)	14,35 (6,59)	13,02 (5,57)	0,98	0,44	-0,25	0,58	0,29	0,41
Manual Dexterity	11,66 (5,96)	11,73 (6,09)	12,66 (6,06)	0,80	0,45	0,16	0,63	0,20	0,49
Upper-Limb Coordination	8,68 (3,12)	8,50 (2,86)	9,32 (3,87)	0,36	0,74	0,25	0,82	0,49	0,58
Bilateral Coordination	11,15 (3,14)	10,52 (2,34)	10,31 (4,02)	0,09	0,90	0,05	0,66	0,81	0,90
Balance	7,52 (2,43)	8,68 (1,52)	9,54 (2,59)	5,40 *	0,04	0,37	0,11	0,01	0,29
Running Speed and Agility	13,66 (3,91)	13,00 (3,74)	15,02 (4,07)	3,51	0,06	0,52	0,38	0,16	0,03
Strength	9,67 (3,75)	10, 02 (4,48)	10,33 (3,48)	0,18	0,83	0,08	0,78	0,63	0,57
Fine Manual Control Composite	45,33 (12,63)	38,76 (7,19)	41,55 (12,06)	1,73	0,23	0,28	0,09	0,28	0,52

4 DISCUSSIONS

This study hypothesized that children with AS and PDD-NOS would demonstrate sensory and motor impairments when compared to normative samples, as identified on the Sensory Profile and the BOT-2. The participants in this study were identified as being typically different or definitely different from the normative sample on all 23 subtests of the Sensory Profile. More than half of the parents reported impairments that were greater than typically developing children in 21 of those areas. Subjectively, this supports the hypothesis that children with AS or PDD-NOS have sensory impairments as compared to normative samples on the Sensory Profile. On both pretest and midtest, which occurred prior to the start of the intervention phase, 100% of the participants were rated by their parents to have difficulty in several areas of sensory processing. Among the most common sensory impairments in this data were Emotional Reactivity, Inattention or Distractibility, Modulation of Sensory Input Affecting Emotional Responses, Emotional or Social Responses and Behavioral Outcomes of Sensory Processing. Emotional reactivity can be described as having an emotional reaction to sensory input that is more than would typically be expected. A child who is considered emotionally reactive may be overly sensitive to criticism, may cry easily or may offer more than typical affection towards others. A poor score on Inattention and Distractibility would be identified in children who tend to be easily distracted or inattentive. Emotional and Social responses describe inappropriate or immature behaviors, such as throwing temper tantrums, having signs of low self esteem or having excessive fears that interfere with daily routines.

Behavioral Outcomes of Sensory Processing are those daily activities that require the ability to process sensory information, such as writing, performing tasks efficiently and tolerating changes in routine. It appears from the results that the sensory processing impairments identified in the children in this study frequently affect their behavior and their ability to control their emotions. Less common parental concerns, where fewer than 50% of the children were rated as being probably different or definitely different include Sensory Sensitivity, which describes a child who, for example, is overly fearful of movements and heights, and Sedentary behaviors which describe preferences toward quiet activities or activities that do not require much movement.

In order to identify if motor skill impairments existed in this group of children, the BOT-2 was administered during the pretest and midtest phases of the study, prior to the intervention phase. The BOT-2 is a performance-based test which provides objective information regarding a child's ability to perform gross and fine motor skills. The scores achieved by the subjects on the BOT-2 were compared to established age and gender referenced norms. If subjects fell at or below the 18th percentile they were considered to have greater impairments than children who are typically developing. Subtest scores are combined to form composite scores in four key areas of motor skill performance: Fine Manual Control, Manual Coordination, Body Coordination and Strength and Agility. On all of the composite scores obtained during pretest and midtest, more than half of the participants were found to score below the 18th percentile for their age and gender. As a group, the children had the most difficulty with the Manual Coordination and Body Coordination composites. The Manual Coordination composite examines a child's manual dexterity in tasks such as sorting cards, stringing blocks and placing pegs in a pegboard. It also assesses upper-limb coordination through a series of ball skills using a tennis ball. The Body Coordination composite assesses bilateral coordination including hand tasks, hand and feet tasks, and whole body skills, as well as standing balance skills on the floor and on a narrow balance beam. These findings suggest that perhaps the children's greatest difficulties with respect to their motor skills is in their inability to coordinate their bodies to perform fine motor and gross motor movements. The data obtained provides quantifiable evidence to

support the hypothesis that the children with AS and PDD-NOS in this study had motor impairments as compared to children in the normative sample of the BOT-2 who were typically developing. Therefore, the hypothesis is accepted for impairments in Manual Coordination and Body Coordination. The children were also impaired in other areas of motor skill performance, including Fine Manual Control and Strength and Agility, although these impairments were less frequent.

In order to address the hypothesis that children would demonstrate improved motor performance following SI therapy, posttest scores from the BOT-2 were compared to pretest and midtest scores using repeated measures ANOVA. The results indicated that the participants demonstrated significant improvements ($p<.05$) on the Balance subtest, with significant changes occurring from pretest to posttest. Additionally, significance was approached on the Running Speed and Agility subtest ($p=.07$), which assessed a child's running speed and ability to perform repetitive stepping and hopping skills. This means that children demonstrated more success in balancing and coordinating their bodies to perform complex motor skills following the intervention. Composite scores were not significantly impacted following intervention. Therefore, since significant or nearly significant improvements were noted for two subtests of the BOT-2 during posttest that were not present for pretest or midtest, the third hypothesis is accepted for the specific areas of balance and running speed and agility. Therefore, it appears that certain areas of motor function can be improved following SI therapy. It should also be noted that the participants did not demonstrate significant improvements in Fine Motor Precision, Fine Motor Integration, Manual Dexterity, Upper-Limb Coordination, Bilateral Coordination or Strength, which may suggest that some types of motor skills, such as balance, running and agility may response better to ten weeks of SI therapy than other types of motor skills.

The current study that assess children with AS using the Sensory Profile are Dunn and colleagues (2002) and Klyczek and colleagues (2005) both identified difficulty with modulating sensory input in their samples of children with AS. The participant's scores on the Sensory Profile suggest that the children in the current study had impairments in both sensory processing and sensory modulation. This supports the previous research which has provided evidence that there is a connection between sensory processing and sensory modulation, and that these impairments are present in children with ASDs.

Those studies identified similar improvements in sensory-based functional behaviors. These improvements indicated fewer disruptive behaviors, improved attention and improved responses to sensory input. Findings from both studies therefore appear to offer support for the use of SI therapy as an intervention for these children. A more recent case study of a four year old boy with poor sensory processing was reported by Schaaf and McKeon Nightlinger (2007). The results of ten months of individualized SI therapy, provided once a week, resulted in improvements in Sensory Profile scores and the achievement of several established occupational performance goals [22]. The authors suggested that the results obtained indicated that an improvement was made in the child's sensory processing as a result of the intervention. The current study is the second known study to utilize Sensory Profile scores in a pretest-posttest scenario. In both cases, parents reported via the Sensory Profile that improvements were seen in their children's ability to receive, process and integrate sensory information in a manner that allowed for more appropriate and more efficient performance in daily activities (Wahyuni and Wardhani, 2019).

Other researchers have used modified versions of traditional SI therapy in an effort to measure its effectiveness. In an attempt to measure the outcomes of intervention using a 10-week Sensory Integration and Perceptual- Motor protocol, Davidson and Williams (2000) studied the impact of treatment for children with Developmental Coordination Disorders. Unlike the current study which identified

significant improvements in the Balance subtest and nearly significant improvements in the Running Speed and Agility composite of the BOT-2, the Davidson and Williams study did not find significant improvements on tests of motor skills using the Movement Assessment Battery for Children, and the Beery-Buktenica Developmental Test of Visual-Motor Integration (Davidson and Williams, 2000).

5 CONCLUSIONS

After following 10-weeks of SI therapy, respondens demonstrated improvements in behavior, sensory processing and modulation, balance and praxis**.** This is mean that SI therapy may be an appropriate treatment technique for children with AS and PDD-NOS. As more children are being diagnosed with ASD, it is critical that researchers and clinicians address all their needs, including those that involve sensory processing and motor skill performance. This research study provides one of preliminary evidence on the efficacy of SI therapy for children with AS and PDD-NOS.

ETHICAL CLEARANCE

Ethical clearance has been approved by University of Indonesia Public Health Ethics Commite with 436/UN2.F10/PPM.00.02/2018 as ethical number registered.

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Wahyuni, K.L., & Wardhani, K.R. 2019. Pemeriksaan *Profil Sensori Anak.* Jakarta. CV Red Octopus.