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Physical Activity And It's Effects On Sensory Processing In Children With Autism Spectrum Disorder

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PHYSICAL ACTIVITY AND ITS EFFECTS ON SENSORY PROCESSING IN CHILDREN WITH AUTISM SPECTRUM DISORDER

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CHAPTER 1
INTRODUCTION

Autism spectrum disorder ("ASD") is a pervasive developmental issue characterized by deficits in social skills, communication, and repetitive or restricted interests (American Psychiatric Association [APA], 2013). Children with ASD tend to have excessive proprioceptive input, which causes them to look for a way to calm and organize their nervous system (Tomchek, & Dunn, 2007). This behavior may be perceived as disruptive, excessively energetic, or even unsafe. Some of the originally identified features of ASD include difficulty processing, integrating, and responding to sensory stimuli. Impairments in modulating sensory input range from hypersensitivity, which is when a child tends to have over reactivity behavior to under sensitivity, which is hypo reactivity behavior tendencies in sensory areas (Tomchek, et al, 2007). Evaluation of sensory processing is now a component of the ASD diagnosis, and its features (i.e. hyper- or hypo reactivity to sensory input or unusual interest in the sensory aspects of the environment) are now included as one of four possible manifestations of restricted, repetitive patterns of behavior, interests, or activities (APA, 2013).

Children with ASD have shown varied heart rate responses to exercise compared to their typical developing peers (Pace & Bricout, 2015). Heart Rate (HR) is suggested to play a role in abnormal arousal levels, which can lead to behavioral problems with ASD children (Lydon, Healy, & Dwyer, 2013). It has been suggested that behaviors such as self-inflicted injury function to regulate arousal and to reduce the discomfort associated with hypo- or hyper-arousal. Arousal may be defined as the "degree of feeling stimulated" (Bolte et al. 2008, p.777). According the Centers for Disease Control and Prevention (CDC), roughly 1 in 68 children have been diagnosed with ASD. Because of this rising prevalence, researchers are being encouraged to explore what interventions are successful in minimizing the effects of the disorder.

Current estimates show that between 45% and 96 % of children with ASD demonstrate sensory difficulties (Ben-Sasson et al., 2009; Lane et al., 2010). Sensory processing, also referred to as sensory integration or SI, is a term that refers to the way the nervous system receives messages from the senses and turns them into appropriate motor and behavioral responses (Ben-Sasson et al., 2009). Praxis, as related to sensory processing, is the process of generating the idea, then initiating and completing new motor tasks. Sensory processing is influenced by visual, auditory, gustatory, tactile, olfactory, vestibular, and proprioceptive information that is perceived and organized in the central nervous system (Dunn, 2001). Sensory processing allows individuals optimal functioning in daily life activities (Dunn, 2001).

Integrated information obtained from the sense of touch, balance, movement, vestibular, vision, and hearing may be necessary for good motor planning (May-Benson, & Cermak, 2007). Recent research indicates that sensory processing deficits were the biggest difference in typical developing children compared to children with ASD (Provost, Crowe, Aeree, Osbourn, & McClain, 2009). Sensory integration-based intervention has been a useful tool for helping children with ASD engage in social interaction and live rich and meaningful lives (Parham 2002). Anna Jean Ayres developed the theory of sensory integration (“SI”) which focuses on sensory information and neurological processing (Ayres, 1991; Baranek, 2002, Watling & Dietz, 2007). The theory suggests that individuals with ASD suffer from neurological processing and integration is disrupted, which results in disruptive behaviors (Schaaf & Miller, 2005; Watling & Dietz, 2007). SI treatment is designed to provide controlled sensory experiences so that an adaptive motor response is elicited (Baranek, 2002). Interventions based on the classic SI theory use planned, controlled sensory input in accordance with the needs of the child and are characterized by an emphasis on sensory stimulation, active participation of the client, and involve client-directed activities. Research with the ASD population regarding the effectiveness of SI treatment is generally difficult because of children's varying developmental levels and the interactive nature of the treatment. This difficulty is exacerbated because the variability in the symptoms translate to unpredictable responses to intervention (Kasari, 2002).

Pfeiffer, Koenig, Kinnealey, Sheppard, & Henderson, (2011) found significant progress toward individualized goals and a decrease in autistic mannerisms after SI interventions. This study provides preliminary support for using SI interventions in children with ASD, although further research is necessary. Results suggest implementing intervention strategies that are generalized to home and community settings, using tools that allow for individualized sensitive measurement in future studies. Leong, Stephenson, & Carter, (2011) looked at sensory processing interventions and concluded that SI is a controversial intervention. They concluded that individuals responsible for giving the therapy can vary in interpretation of the children with ASD along with the ability to provide appropriate SI directed activity (Leong et al, (2011). However, other studies have shown positive outcomes from sensory intervention therapy (SIT). Preis, et al, (2014) displayed that SIT yielded better communication and engagement than the condition immediately prior, possibly supporting its role in communication intervention. Further research should examine SIT and its effects on improving ASD impairments (Preis, et al, (2014).

Along with sensory processing deficits, children with ASD have been shown to have motor characteristics which limit their muscular coordination (Molley, Dietrich , & Bhattachary, 2003). Several deficiencies have been observed in their fine and gross motor skills (Emck et al., 2011; Pan, 2008), along with difficulty performing holistic movements such as throwing, catching and rolling a ball, as well as running and balancing. Furthermore, issues with balance often result in atypical walking patterns and unintended actions (Vernazza-Martin et al., 2005).

Many children with ASD suffer from symptoms of poor motor coordination, social cognition, intelligence, and language (Dyck & Piek , Hay, & Hallmayer, 2007). The evidence of physical impairment as well as behavior deficits have lead researches to look at physical activity interventions. Sowa, & Meulenbroek, (2012) reviewed 16 studies and all suggested on average, exercise interventions led to a 37% improvement in overall symptomatology of ASD. Prescribing exercise and physical activity is beneficial for reducing and helping control impairments (Srinivasan, et al., 2014). Proper evaluation of each individual prior to intervention will ensure that they are providing them with an environment and program that will provide the maximum benefit to the individual (Srinivasan, et al, 2014).

There is a significant relationship between postural stability and severity of symptoms in children with ASD (Travers, Powell, Klinger, & Klinger, 2013). ASD-afflicted children who had more severe repetitive behavior and social symptoms also exhibited more postural waver during standing position (Travers, et al., 2010). These tendencies may be due to symptoms of cerebellar atypicalities and therefore, more research is needed to increase our understanding of these findings. The strong correlation between sensory response and motor coordination has led to the explorations of SI interventions pertaining to physical movement (May-Benson, & Koomer, 2010).

May-Benson et al., (2010) found the SI approach may result in positive outcomes in the areas of sensorimotor skills and motor planning; socialization, attention, and behavioral regulation; reading and reading related skills; and individualized goals for the study populations, other meta-analyses do not concur for individuals with autism. According to a review of current treatment methods by the National Autism Center (2009), the sensory integrative package was deemed an ‘unestablished intervention’ with little or no evidence to establish treatment effective-ness for ASD. This rating was supported more recently by (Kadar, McDonald, & Lentin 2012).

Purpose

The purpose of this study is to assess the effect of consistent physical activity (adult-directed coordination and balance activities) on sensory processing, praxis, and social participation in students identified with ASD.

Hypothesize

We hypothesize that adult-directed coordination and balance activities will improve sensory processing, praxis, and social participation in elementary-aged students with ASD.

CHAPTER 2

METHOD

Participants

Participants consisted of 4 children diagnosed with ASD (*n* = 3 male and *n* = 1 female; *M* age = 8 years, *SD* = 2.12). All participants were previously diagnosed with ASD from the Southern Illinois University Center for Autism Spectrum Disorder SIU CASD). Legal guardians and participants signed Human Subject Committee approved consent forms providing information with the right to opt out of the study at any time. All participants were not receiving services from the SIU CASD or any other therapy at the time of the study.

Research Design

Prior to implementation of adult-directed physical activities, guardians completed the Sensory Processing Measure, Home Form (SPM Home Form; described below in the Instrumentation section), and returned them to the researcher. These were scored and subjects were identified for the study based on total scores in the "definite dysfunction to some problems" range. Instructing children with ASD to move and be physically activate requires specific direction and illustrations (Aksay & Alp, 2014). To properly ensure each participant received an adequate amount of instructions the study had two separate groups. Each group had two participants that were randomly selected. Both groups were given the same amount of adult-directed physical activities. The adult directed physical activity encouraged and facilitated balance, bilateral coordination, hand-eye coordination, proprioception, strength, directionality, crossing midline, and motor planning. Activities included resistive activities such as pushing, pulling, catching, throwing, climbing, balance beam, running, hopping, and crawling. These structured activities were provided two times a week for 20 minutes at the CASD. At the end of four weeks, the parents filled out another SPM Home Form and returned it to the researcher.

Instrumentation

The SPM Home Form (Parham & Ecker, 2007; Parham, Ecker, Miller Kuhaneck, Henry, & Glennon, 2007) is an integrated system of rating scales that enables assessment of sensory processing issues, praxis, and social participation in school-aged children. The SPM Home Form consists of 75 items and is completed by the child's parent or guardian. Each item is rated in terms of frequency of the behavior on a 4-point scale. The response options are Never, Occasionally, Frequently, and Always. A numerical score (1 through 4) is assigned to each rating, with higher scores representing higher frequency of dysfunctional behaviors. The raw score of the SPM is simply the numerical total of the item ratings for that scale. Because of the way the SPM is coded, a higher raw score always indicates a higher level of problems or dysfunction than a low raw score. The SPM Home Form yields eight norm-referenced standard scores related to sensory processing. The standard score for each scale enables classification of the child's functioning to be placed into one of three interpretive ranges: Typical, Some Problems, or Definite Dysfunction. (Parham et al., 2007).

Reliability: The SPM scale performed well on two key indexes of reliability: internal consistency and temporal stability. In statistical terms, alphas of .70 or greater are considered acceptable, and alphas of .80 or greater are considered ideal for behavioral rating scales. In a standardization sample, seven of eight SPM Home Form scales have alphas of .80 or greater. SPM Home Form scores were highly correlated across a 2-week interval. The findings revealed excellent temporal stability (test-retest reliability) (Parham & Ecker, 2007). The total scores of the first SPM Home Form and final SPM Home Form were then compared to see if there were any changes.

Procedure

The participants engaged in adult-directed physical activity for 20 minutes 2 days a week for four weeks. The entire 4week adult-directed physical activity took place in a classroom at the SIU CASD. The classroom was empty except for the materials used for the activity. The participants began with a 5 minute warm-up in which they engage in light yoga and breathing activities followed by predetermined activities in stations in the classroom. The stations incorporated balance, bilateral coordination, hand-eye coordination, proprioception, strength, directionality, crossing midline, and motor planning. Activities included, wall push-ups, bean bag toss, obstacle course, balance beam, skipping, hopping, and/or ball activities. Verbal instructions along with a brief illustration of how to perform the coordination and balance activities were given by the same researcher at the beginning of each activity. Every 20 minute session ended with a 5 minute cool-down period which consisted of relaxing yoga, static stretching, and calm breathing. The exact procedure has not been done before, however physical activity and yoga have been suggested as useful interventions for children with ASD (Srinivasan, et al., 2014; Sowa, et al., 2012).

Data Collection

The dependent variable, the data collected from the initial SPM, was compared to the final SPM score. Differences between the pre SPM Home Form scores and post SPM Home Form Scores were analyzed using IBM SPSS Statistics for Windows Version 22.0 (Armonk, NY, USA). The mean scores were analyzed by using a Two-Way ANOVA to evaluate significant differences between the pre and post evaluations. The criterion for significance was set using an alpha level of $p \leq 0.05$.

The total raw score, mean *T*-score, standard deviation, and total sensory system (TOT) scores are added up using the SPM AutoScore Form. The *T*-score has a mean of 50 and a standard deviation of 10. The mean *T*-score of 50 represents the functioning of a typical developing child.

CHAPTER 3

RESULTS

A summary of the SPM Auto Score Forms show the average pre and post scores, standard deviation, and *T*-score from the 8 categories Social Participation (SOC):Vision (VIS), Hearing (HEA), Touch (TOU), Taste and Smell (T&S), Body Awareness (BOD), Balance and Motion (BAL), Planning and Ideas (PLA), and Total Sensory System (TOT). These can be found below in Table 1. The TOT average score decreased by 2 points from 106. 75 to 104.75, along with the average *T*-score, which also decreased .25 going from 67 to 66.75. Overall, every category decreased in average score and *T*-score except TOU, which increased .5, going from 67 to 67.5.

Table 1. Combined average scores, standard deviation, and *T*-Scores from all participants.

Category	Average Score	Std Dev	T-Score	Category	Average Score	Std Dev	T-Score
SOC				**BOD**			
Pre	29.75	3.63	71.5	Pre	21.75	6.26	66.5
Post	28	3.08	69	Post	21.5	7.26	66.25
Change	1.75		2.5	Change	0.25		0.25
VIS				**BAL**			
Pre	18.5	2.06	64.75	Pre	21	2.23	66.25
Post	18	4.18	63	Post	19.25	3.42	63.75
Change	0.5		1.75	Change	1.75		2.5
HEA				**PLA**			
Pre	14.75	0.83	65.25	Pre	25	4.36	70.5
Post	13.75	2.28	63.75	Post	23.75	7.19	67.5
Change	1		2.5	Change	1.25		3
TOU				**Total**			
Pre	22.75	5.4	67	Pre	106.75	14.77	67
Post	22.75	2.59	67.5	Post	104.75	16.13	66.75
Change	0		-0.5	Change	2		0.25
T&S							
Pre	8	1.22					
Post	9	2.18					
Change	-1						

Table 2. Significance of data

Category	**P-value**
Social	0.49
Vision	0.837
Hearing	0.441
Touch	1
Taste and Smell	0.454
Body Awareness	0.96
Balance and Motion	0.424
Planning and Ideas	0.776
Total	0.861

Results of the ANOVA indicated no significant difference for all 8 categories on the SPM Home Form and are represented above in Table 2. None of the categories on the SPM Home Form achieved the significant value of alpha level of $p \leq 0.05$.

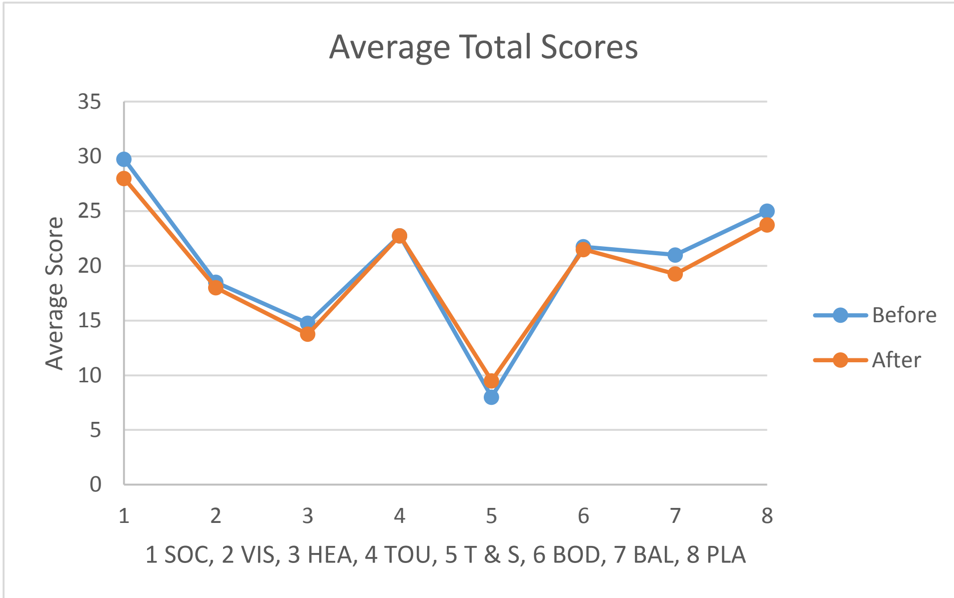

Figure 1. Average total raw scores before and after for each category on the SPM Home Form. (1) Social Participation, (2) Vision, (3), Hearing, (4) Touch, (5) Taste and Smell, (6) Body Awareness, (7) Balance and Motion, (PLA) Planning and Idea.

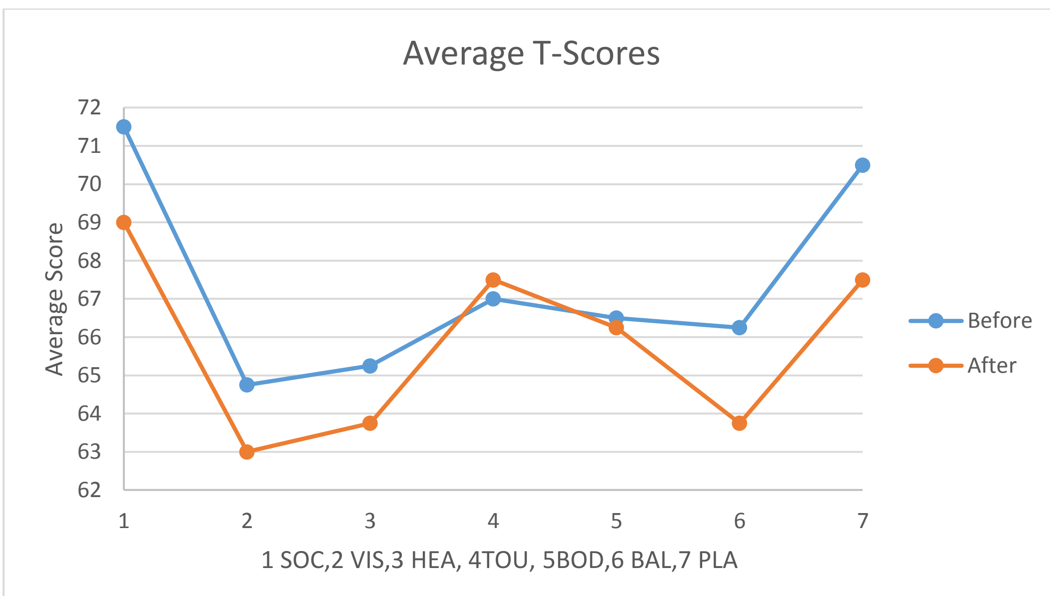

Figure 2. Average T-Scores before and after for each category on the SPM Home Form. (1) Social Participation, (2) Vision, (3), Hearing, (4) Touch, (5) Taste and Smell, (6) Body Awareness, (7) Balance and Motion, (PLA) Planning and Idea.

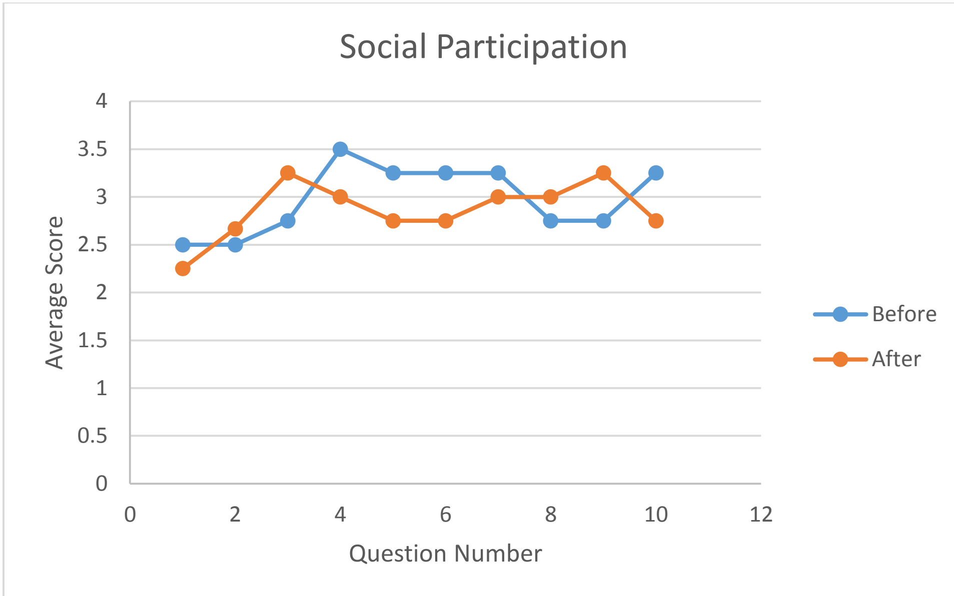

Figure 3. Averages social participation raw scores. (Question number) represents each social participation question asked on the SPM Home Form.

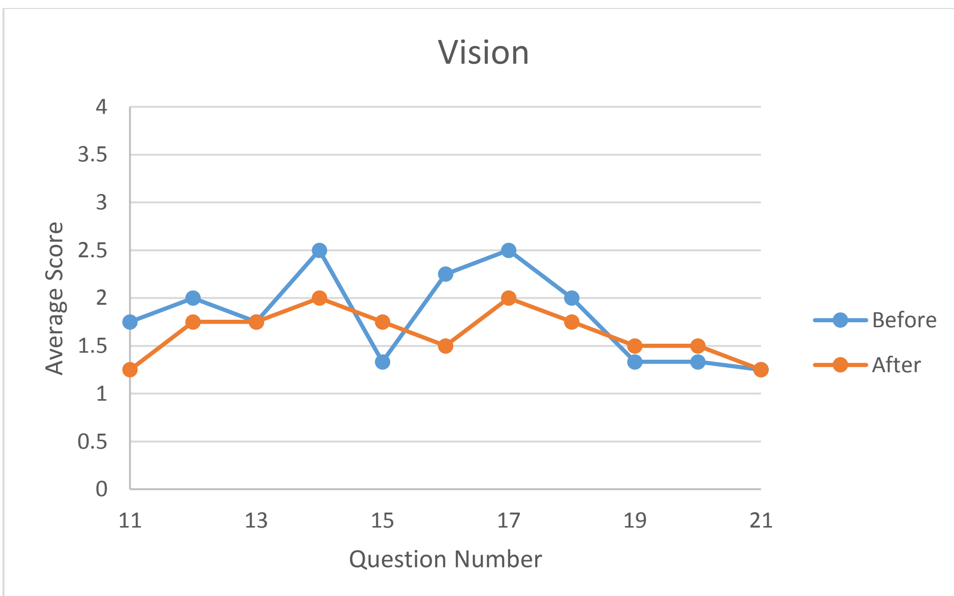

Figure 4. Average vision raw score. (Question number) represents each social participation question asked on the SPM Home Form.

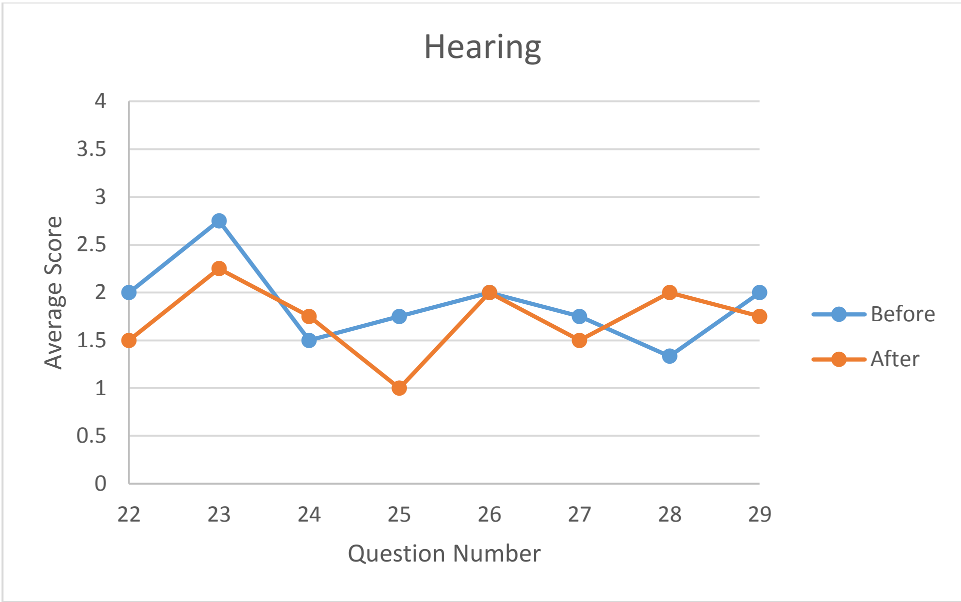

Figure 5. Average hearing raw scores. (Question number) represents each social participation question asked on the SPM Home Form.

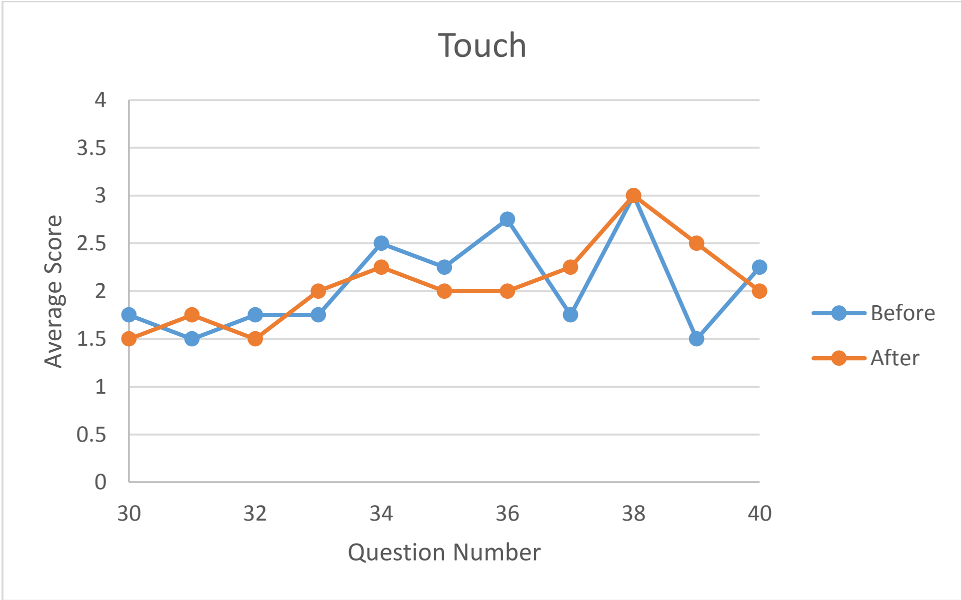

Figure 6. Average touch raw scores. (Question number) represents each social participation question asked on the SPM Home Form.

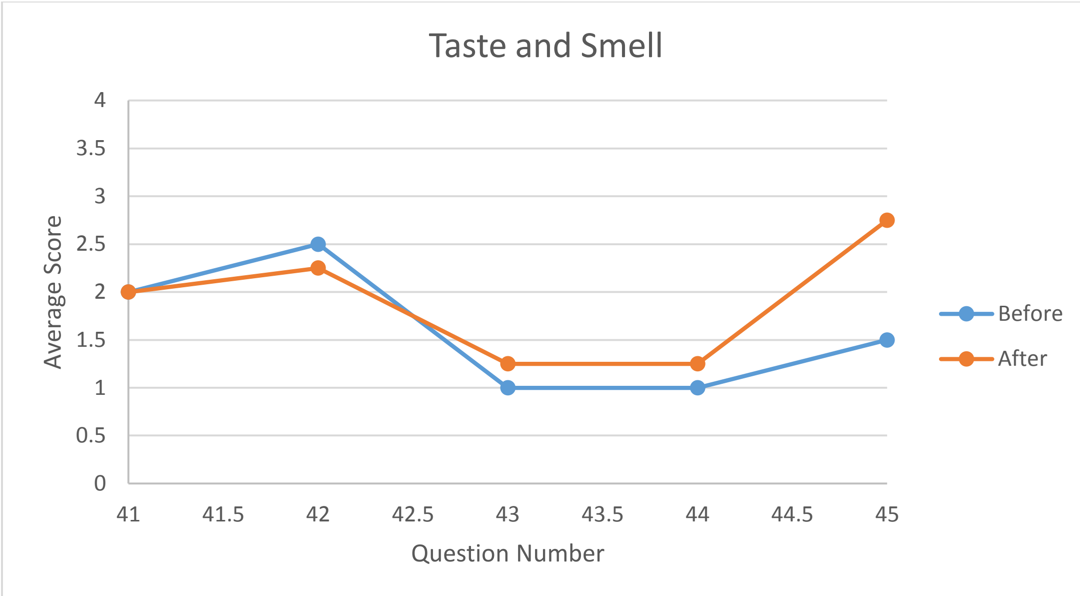

Figure 7. Average taste and smell raw scores. (Question number) represents each social participation question asked on the SPM Home Form.

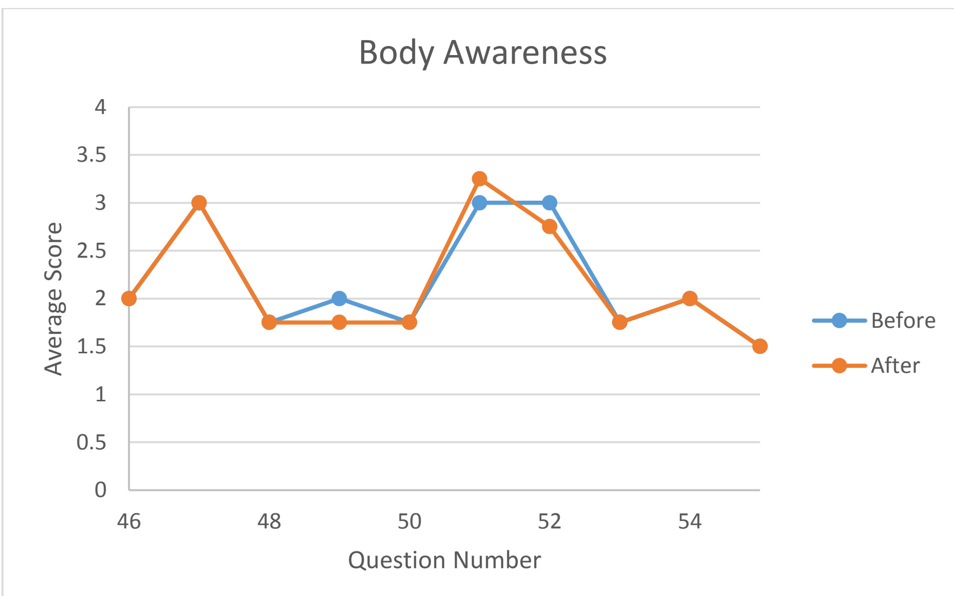

Figure 8. Average body awareness raw score. (Question number) represents each social participation question asked on the SPM Home Form.

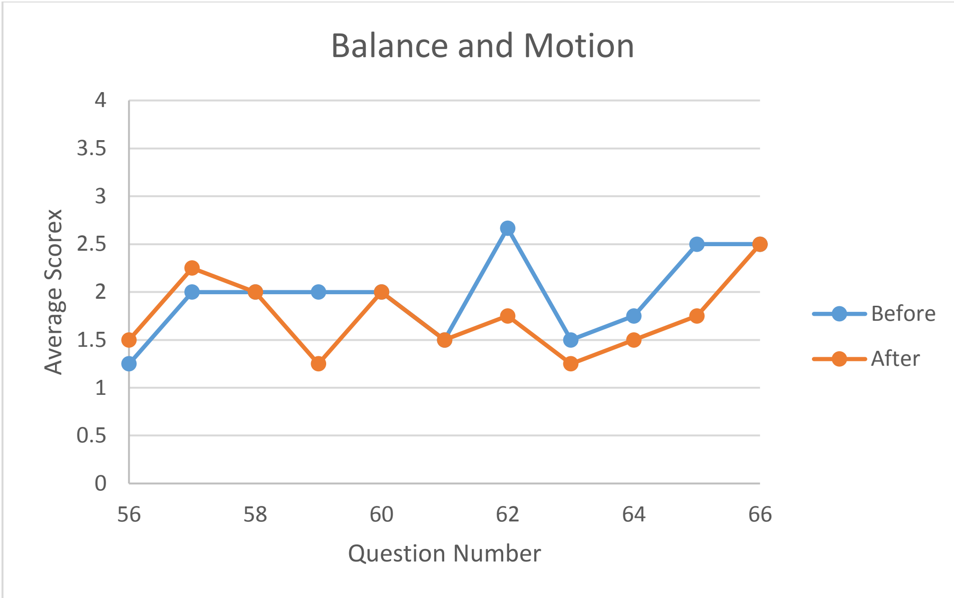

Figure 9. Average balance and motion raw scores. (Question number) represents each social participation question asked on the SPM Home Form.

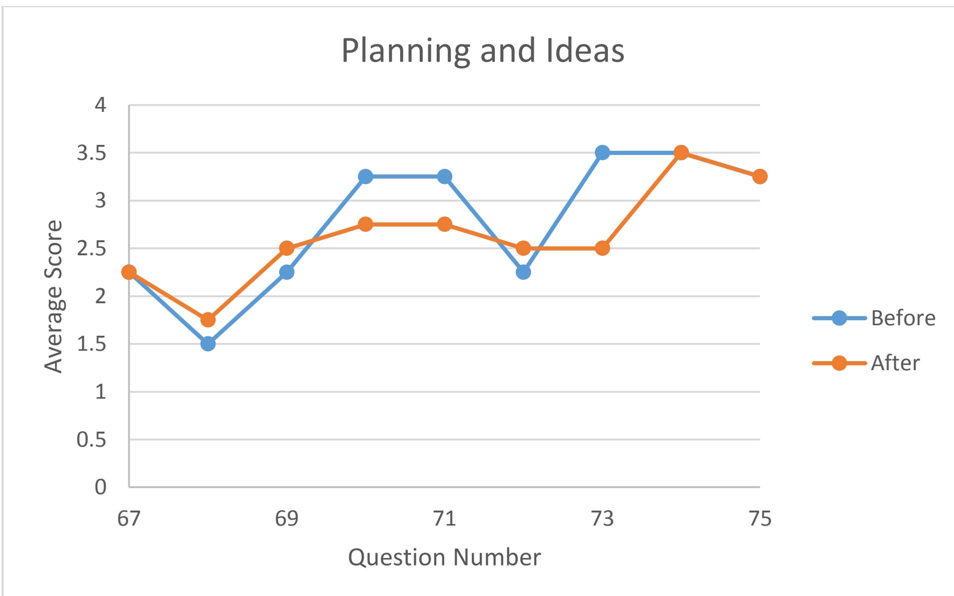

Figure 10. Average planning and ideas raw scores. (Question number) represents each social participation question asked on the SPM Home Form.

CHAPTER 4

DISCUSSION

The purpose of this study was to assess the effect of consistent physical activity (adult-directed coordination and balance activities) on sensory processing, praxis, and social participation in students identified with ASD. We hypothesized that adult-directed coordination and balance activities would improve sensory processing, praxis, and social participation in elementary-aged students with ASD.

The results did not show significant improvement in sensory processing, praxis, or balance on the pre to post raw score or the *T*-score SPM Home Form. In order to be practically significant, the *T*-score and the raw score value would be have to change 10 points for each individual category (Parham et al., 2007). It is important to remember that the way the SPM is coded, a higher raw score always indicates a higher level of problems or dysfunction than a lower raw score. A change of 10 points in either direction would change the classification of the child's functioning into one of the three interpretive ranges: Typical, Some problems, Definite Dysfunction (Parham et al., 2007).

Despite the results not being significant there was an average decrease in raw score and *T*-score in every category except T & S. This suggest a potential positive value of this intervention for helping to decrease sensory processing impairments. The pre to post average TOT scores decreased in raw score by 2 and the *T*-score decreased by .25. The three categories with the greatest change in scores were PLA, BAL, and social category. Improvement in the PLA category helps to support the hypothesis for physical activity improving praxis in children with ASD, along with the previous theory suggesting physical activity improving praxis in children with ASD (May-Benson, et al., 2007; May-Benson, et al., 2010). The BAL raw score decreased by 1.75 along with SOC raw score, which decreased by 1.75. The BAL average *T*-score decreased by 2 points as well.

A similar study looked an intervention using physical activity and found improvement in balance in children with ASD (Emck et al., 2011). The study suggested that performing gross motor activities can not only help balance, but social participation as well (Emck et al., 2011). Another study looked at an intervention using movements such as, throwing, running, and catching found improvement not only physical impairments, but social as well (Aksay, et al., 2014). One possible theory for improvements in social participation could be the confidence that comes from improving motor function (Aksay, et al., 2014; Emck, et al., 2011). The present study helps to support the previous theory, but further research should look to find significant improvements.

Very few studies have looked at interventions that include SI and physical activity. SI movements can improve motor function and improvements in motor function can improve SPM's (May-Benson et, al., 2010). The previous study gives a possible explanation for the improvements in SPM score coming from the SI moments. The study's results helped to further support the need for future research interventions and therapies to help reduce the impairments found with sensory processing, praxis, and social participation in children with ASD.

Limitations

The limited improvements found in children with ASD may be attributed to the study having a small sample size. Having a larger sample size would increase the chance of finding a significant difference. The current study was a 4 week study, which could possibly be a reason for the minimal changes in the scores. SPM Form is filled out by the parent and having a longer study would give the parent more time to observe the behaviors of the child.

Future Direction

Future research should look at appropriate physical activity interventions lengths and effects on SPM, balance, and social participation. Specifically, studies can look at interventions to address each category on the SPM Form. For example, looking at an exercise program that might help improve the individuals BAL or PLA. The study could look at evaluating the participants to see areas that need improving on the SPM Form and then aiming the intervention to help improve in the area. The need to look at children with ASD have a significant amount of SPM and physical deficits that restrict their everyday life (Provost et al., 2009; Preis, et al, (2014; Travers, et al., 2010). The need for future studies to look at programs to help improve SPM, praxis, and social participation is evident.

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Major Professor: Philip M. Anton, Ph.D.