The Effects of Physical Activities on Stereotypic Behaviors and Task Engagement in
Preschool Children with Autism Spectrum Disorders

Dissertation

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By

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Abstract

This study examined the effects of two types of physical activities (locomotor [LC] and object manipulation activity [OM]) on stereotypic behaviors (SBs) as well as on-task behaviors in three preschoolers with an ASD. A preference assessment and functional analysis were conducted prior to the intervention. Using a multielement design with a three-component test sequence approach (Morrison, Roscoe, & Atwell, 2011), SBs, on-task behaviors as well as heart rates were measured in three consecutive 5-minute phases: pre-physical activity (Pre-PA), physical activity (PA), and post-physical activity (Post-PA). Results showed that SBs in two of the three participants were immediately decreased in PA LC. All participants engaged in fewer SBs in Post-PA LC compared to Pre-PA LC. LC positively influenced both vocal and motor SBs. In contrast to LC, increased SBs were found in two of the three participants in PA OM and in all participants in Post-PA OM. Heart rate results indicated that all participants experienced more vigorous physical activity during LC than OM. An inverse relationship was found between SBs and on-task behaviors in two of the three participants. LC activity was considered effective in decreasing SBs and increasing on-task behaviors. Results provided implications for future research relative to physical activity and changes in SBs in young children with ASDs.
Dedication

I would like to dedicate this work to my advisor, to my husband and my son, as well as to all other friends and family members who helped me get to this point.
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Chapter 1: Introduction

Autism Spectrum Disorders (ASDs) are pervasive developmental disorders whose etiology is still unknown (Johnson & Myers, 2007). The prevalence of ASDs has rapidly increased. According to the Centers for Disease Control and Prevention (CDC), approximately 1 in 88 children (or 11.3 per 1000) in United States has been identified with an ASD (CDC, 2012). This report came from the Autism and Developmental Disabilities Monitoring (ADDM) Network in 2008, which has been identifying the number of 8-year-old children with ASDs living in 14 diverse communities throughout the United States. These 14 communities account for more than 8% of the 8-year-old children in the U.S. When compared to ADDM Network’s last report in 2009 and first report in 2007, the current report showed 23% and 78% of increased number of children diagnosed with autism, respectively. It is not clear if this rapid increase in prevalence is due to greater awareness or other reasons.

There is now a greater emphasis on the importance of services for children with ASDs and their families. Literature has reported higher parental stress, lower levels of self-esteem, and higher vulnerability to mental health problem in parents of children with ASDs compared to parents of typically developing children. These issues have been problems with behaviors, communication, and education (e.g., Bakér-Ericzen, Brookman-Frazee & Stahmer, 2005; Dunlap, 1994; Hoffman, Sweeney, Hodge, Lopez-
ASDs not only impact all areas of development but also cause major social, financial, and emotional problems for families (Bakér-Ericzen et al., 2005; Gray, 2002; Ludlow, Skelly, & Rohleder, 2012).

The Diagnostic and Statistical Manual of Mental Disorders (Fourth Edition Text Revision, DSM-IV–TR) provides guidelines for the diagnosis of ASDs and identifies sub-categories including (a) Autistic Disorder, (b) Asperger’s Disorder, (c) Childhood Disintegrative Disorder, (d) Rett’s Disorder, and (e) Pervasive Developmental Disorders–Not Otherwise Specified (PDD–NOS) (American Psychiatric Association [APA], 2000). According to the DSM-IV-TR, the core features of ASDs include a) impairment in social interaction, b) communication deficits, and c) a restricted, repetitive behavioral repertoire (APA, 2000).

Leo Kanner first described autism as a disorder in 1943. The case histories of 11 children in Kanner’s report illustrated similar patterns of behavior that included social remoteness, repetitive and ritualistic behaviors, and echolalia. Restricted, repetitive, and stereotyped patterns of behaviors in Kanner’s observations include spinning and arranging objects, head-shaking, jumping up and down, stereotyped finger movements, and vocal repetitions such as humming, or whispering repeating the same words and same tones (Kanner, 1943). These behaviors were characterized by Kanner (1943) as ‘insistence on sameness in the environment.’

In fact, such behaviors can also be found in individuals with intellectual disabilities and in behavioral repertoires of individuals without disabilities (Singer, 2009; Troster, 1994). Examples of this include foot tapping and nail biting (Singer, 2009; Smith
Despite the fact that individuals without ASDs can exhibit some autism-related behaviors, “repetitive and stereotyped patterns of behavior, interests, and activities” are one of three distinguishing features of individuals with ASDs (APA, 2000). Using such behavioral diagnostic criteria, an individual is diagnosed when at least one of the following criteria are met: (a) they display an encompassing preoccupation with one or more stereotyped and restricted patterns of interest that is abnormal either in intensity or focus; (b) the individual has an apparently inflexible adherence to specific, nonfunctional routines or rituals; (c) they demonstrate stereotyped and repetitive motor manners (e.g., hand or finger flapping or twisting, or complex whole-body movements); and (d) the individual has a persistent preoccupation with parts of objects (APA, 2000). In particular, “repetitive and stereotyped behaviors” are included in the diagnostic criteria for all sub-categories of ASDs. As these disorders cover a broad spectrum, each individual may exhibit different characteristics and severity of behaviors.

In general, the term “stereotypic behaviors” has often been used to define repetitive and self-stimulatory body movements or vocal responses (McBride & Panksepp, 1995). According to Cunningham and Schreibman (2008), stereotypic behaviors can be verbal or nonverbal, simple or complex, and can be accompanied by fine or gross motor movements, exhibited with or without objects. Collectively, stereotypic behaviors are placed on a broad spectrum such as tapping, body rocking and swaying, arm-and-hand flapping, finger flicking, toe walking, self-slapping, jumping, facial expressions, and repeated vocalizations (Nijhof, Joha, & Pekelharing, 1998; Singer, 2009).
Stereotypic behaviors can also interfere with psychosocial functioning and can cause physical injuries (APA, 2000; LaGrow & Repp, 1984). That is repetitive self-stimulation can potentially damage the body (Dhossche, Wing, Ohta, & Neumärker, 2006; Jones, 1987; Rojahn, 1986; Turner, 1999). An example is nail biting which can eventually damage the nails (i.e., bleeding or infection). In this study, restrictive repetitive and stereotyped behaviors will be used and referred to as ‘SBs.’

**Learning and SBs in Children with ASDs**

Behaviors that are observed in individuals with ASDs are often regarded as socially inappropriate and stigmatizing (Repp, Singh, Karsh, & Deitz, 1991; Stricker, Miltenberger, Anderson, Tulloch, & Deaver, 2002) which can be self-injurious and aggressive (Guess & Carr, 1991; Morrison & Rosales-Ruiz, 1997; Rojahn, 1986; Schroeder, Rojahn, Mulick, & Schroeder, 1990). With the increased prevalence of school-age children with ASDs, teachers are more likely to have students with ASDs who have SBs in their classes and face problems related to their learning.

The negative impact of engaging in SBs when acquiring new skills has been reported (Baker, 2000; Baker, Koegel, & Koegel, 1998; Honey, Leekam, Turner, & McConachie, 2007). For example, a survey study by Honey et al. (2007) indicate that Children with ASD aged 2-8 years old who exhibit a greater degree of repetitive behaviors are less likely develop play activities and this may be related to delays in symbolic communication development. Researchers also report that SBs interfere with learning not only new skills but also the application of previously learned behaviors (Koegel & Covert, 1972; Morrison & Rosales-Ruiz, 1997). Lovaas, Newsom, and
Hickman (1987) argue that children with ASDs tend to be indifferent to external stimuli and thus more likely to process those stimuli less efficiently or incorrectly. In addition, SBs interfere with learning when they appear in a form of aggression, tantrums, and self-injury (Machalicek, O’Reilly, Beretvas, Sigafoos, & Lancioni, 2007; Matson & Minshawi, 2007; Matson, Wilkins, & Macken, 2009; McClintock, Hall, & Oliver, 2003).


Physical Activity Interventions for SBs

Studies on physical activity interventions for individuals with ASDs have reported positive effects in the decrease of SBs and an increase of appropriate responding such as a higher level of correct academic responding, amount of work completion, and lower out-of-seat behavior (Petrus et al., 2008). Research has been conducted to identify the
effects related to antecedent physical activity on SBs. Petrus et al. (2008) conducted a systematic literature review on the effectiveness of physical activity interventions in order to assess the extent to which physical activity reduces SBs of children with ASDs. Of the seven articles identified and published between 1982-2003, six used jogging and walking interventions (Celiberti, Bobo, Kelly, Harris, & Handleman, 1997; Kern, Koegel, Dyer, et al., 1982; Kern, Koegel, & Dunlap, 1984; Levinson & Reid, 2003; Rosenthal-Malek, & Mitchell, 1997; Watters & Watters, 1980) and one study used an aquatic intervention (Bumin, Uyanik, Yilmaz, Kayihan, & Topcu, 2003). Vigorous jogging was found to be more effective than mild walking (i.e., Celiberti et al., 1997; Levinson & Reid, 1993; Kern, Koegel, & Dunlap, 1984).

Additional studies have been conducted that were not included in the Petrus et al. review. Those studies used various types of physical activity to decrease SBs. For example, Elliott, Dobbin, Rose, and Soper (1994) used a general motor activity program that consisted of an exercise bike, stair-stepper, lifting light weights, and walking and compared the effects to traditional vigorous jogging and a non-exercise condition. Roller-skating was also used as an alternative type of physical activity to intervene SBs in an 8-year-old with developmental disabilities (Power, Thibadeau & Rose, 1992). Cannella-Malone, Tullis, and Kazzee (2011) used a physical activity routine that consisted of various gross motor tasks such as running, jumping, yoga poses, scooting, jump roping, and stretches.
Significance of the Study

Researchers have noted preventive and practical benefits on the use of physical activity as an antecedent-based intervention (Conroy, Asmus, Sellers, & Ladwig, 2005) in reducing inappropriate behaviors in individuals with developmental disabilities. The benefits include integration into age-appropriate activities (Hawkins, 1982), physical fitness and self-concept improvement (Allen, 1980), ease of implementation and cost-effectiveness (Bachman & Fuqua, 1983), and increased engagement and skill learning (Bumin et al., 2003; Celiberti et al., 1997; Kern, Koegel, Dyer, et al., 1982; Kern, Koegel, & Dunlap, 1984). Reducing SBs could further enhance the learning due to increased attention and participation (e.g., Cannella-Malone et al., 2011; Kern, Koegel, Dyer, et al., 1982; Rosenthal-Malek & Mitchell, 1997). Furthermore, Baumeister and MacLean (1984) suggest that the lack of physical activity itself might contribute to increased aberrant behavior.

Previous studies provide limited evidence about the effects of physical activities on SBs (Petrus et al., 2008). This limited evidence is attributed to limited systematic replications of previous intervention procedures that address the believability and reliability of the findings. There has been an insufficient number of rigorously designed studies. For example, previous studies have attempted to replicate the procedures and results by using jogging and walking as a vigorous or mild form of physical activity; however, researchers have not used valid measures to determine intensity. The limited number of studies in this area has used various measures of physical activity intensity. These measures included an increased breathing rate and/or flushed face (Kern, Koegel,
Dyer, et al., 1982, Kern, Koegel & Dunlap, 1984), and an increase in heart rates (Elliott, Dobbin, et al., 1994; Levinson & Reid, 1993). However, most studies do not describe any indication about how the two types of physical activities were measured by valid instruments. The current study attempts to provide evidence on how particular types of physical activities affect SBs as well as on-task behaviors in young children with ASDs using a valid measure of physical activity intensity.

First, one of the weaknesses in previous studies includes insufficient information and understanding about SBs in general as well as how SBs interact with the intervention components. Most antecedent physical activity studies have not determined the functions of participants’ SBs. Therefore, what contingencies maintain target behaviors remains unclear. Furthermore, physical activity preferences were not taken into consideration despite the fact that preferences can act as reinforcement. There have been limited studies conducted in physical activity settings and those that incorporate both preference assessment and functional analysis. Consideration relative to the factors maintaining SBs and how participant preferences influence interventions are strongly encouraged when conducting future antecedent physical activity research as well as teaching students with ASDs in physical activity settings.

Second, Petrus et al. (2008) in their review pointed out antecedent physical activity interventions have provided weak to moderate valid evidence because with existing evidence one does not know which types or intensities of activities would produce optimal outcomes. Therefore, it is difficult to suggest best practices for those who work with individuals with ASDs. This study using both a valid measure of physical
activity intensity as well as consistent intervention components can provide practical suggestions for those teaching young children with ASDs.

Lastly, there is limited evidence on how different types of SBs respond to different types of physical activity. Reid, Factor, Freeman, and Sherman (1988) observed different types of SBs (i.e., motor, vocal/oral, and other) and reported all of them decreased after jogging when compared to walking. Similarly, Celiberti et al. (1997) showed decrease in both motor and visual SBs after jogging. Therefore, different types of SBs could respond differently to various types of physical activities. Fundamental motor skills are frequently used in educational settings to improve gross motor competence of children. However, limited studies have been conducted comparing the effects of object manipulation and locomotor activities on different types of SBs. Therefore, this study can help identify how object manipulation and locomotor activities affect SBs and how vocal and motor SBs respond to each of those activities. This study aimed to identify the effects of two types of antecedent physical activities on SBs in preschool aged children with ASDs. The function of SBs and activity preference were taken into consideration. Vocal and motor SBs were analyzed separately. In addition, heart rates were measured to identify the intensities of physical activities. This study was considered to help better understand the effects of physical activities to reduce SBs and to enhance on-task behaviors of children with ASDs. Upon obtaining this information, interventions can be created to support children with ASDs in other physical activity settings (e.g., physical education).
Theoretical Framework

The theoretical framework to guide this study was situated in behaviorism. More specifically under behaviorism, this study supports the functional analysis perspectives of Iwata, Dorsey, Slifer, Bauman, and Richman (1982/1994) which provide a comprehensive view of the roles of automatic and social reinforcement on SBs. The functional analysis perspectives are closely related to motivational operations (Skinner, 1957). As Skinner (1957) described in a three-term contingency of operant conditioning in the development of scientific verbal behavior, motivational variables include deprivation-satiation operations and aversive stimulation. The effectiveness of antecedent stimuli is dependent upon motivational features of antecedent events. Functional analysis approaches have enabled researchers to better identify contingencies that maintain problem behaviors through manipulation of motivational aspects that influence behavior. This increases the likelihood to effectively manipulate relevant antecedent events and consequences in order to increase or reduce the target behaviors. The perspectives of Iwata, Dorsey, et al. (1982/1994) contributed to the understanding of potential environmental determinants of problem behaviors and to the design of effective intervention strategies enabling them to produce better outcomes.

Purpose of the Study

The first purpose of this study was to determine the effects of 1) object manipulation activities or 2) locomotor activities on SBs in preschool children with ASDs within individual gross motor activity settings. The second purpose was to determine the effect of both types of activities on task engagement.
Research Questions

1. What are the effects of object manipulation and locomotor activities on SBs of participants with ASDs?
   1a) Will SBs change in the physical activity phase when compared to pre- and post-physical activity phases as a function of object manipulation or locomotor activity?
   1b) Will SBs change in the post-physical activity phase compared to the pre-physical activity phase as a function of object manipulation or locomotor activity?
   1c) Will SBs change in the follow-up phase compared to the pre-physical activity phase for as a function of object manipulation or locomotor activity?
   1d) What are the effects of object manipulation and locomotor activities on vocal and motor SBs?

2. What are the effects of object manipulation and locomotor activities on heart rates of participants with ASDs?

3. What are the effects of object manipulation and locomotor activities on on-task behaviors of participants with ASDs in the post-physical activity phase compared to the pre-physical activity phase?

4. What is the relationship between SBs and on-task behaviors observed in participants with ASDs?

   Delimitations of the Study

The study is delimited to:
1. Preschool children with ASDs who display SBs such as hand flapping, repetitive vocalizing, body rocking, and object-mouthing.

2. Continuous locomotor activities and object manipulation activities.

3. Physically demonstrated overt behaviors.

4. Individualized activity sessions delivered during the school day.

5. Study participants come from one preschool setting.

6. The age of participants range from 3 to 6 years of age.

Operational Definitions

The following terms have been operationally defined for this study.

1. Locomotor (LC) activity: activity that requires the use of hands or feet to move the body from one place to another place in a horizontal or vertical plane such as walking or jumping. Locomotor activity can also be produced through the use of locomotor activity items such as a mini-trampoline, scooter board, etc. Locomotor activity is considered more vigorous as measured by a heart rate monitor and continuous in format when compared to object manipulation activity.

2. Object manipulation (OM) activity: activity that requires the use of hands or feet such as catching, kicking, throwing, striking, dribbling, and rolling. Object manipulation activity involves items such as balls, basket hoops, beanbags, and bowling pins. Object manipulation activity could be interactive since throwing and catching activities requires having a partner.

3. Task engagement: on-task behaviors occur when the participant uses an item appropriately (i.e., as it is designed to be used), exhibits proper skills for the task (i.e.,
jumping during locomotor activity), visually attends to the investigator while explanations are given, and transitions appropriately between activities. On-task behavior is present when behavior is relevant to the activity despite the behavior being irrelevant to investigator’s direction (rolling a ball when the investigator said “throw the ball” during object manipulation activity) and/or when the participant is on-task engaging in SBs at the same time.

4. Stereotypic behaviors (SBs): repetitive and self-stimulatory behaviors that are frequently observed. These behaviors are inappropriate for specific contexts and could be aggressive or physically damaging to self or others.

5. Vocal stereotypic behaviors: any vocalizations that have indefinable characteristics of stereotypic behaviors including repeatability, self-stimulatory, and contextual inappropriateness.

6. Motor stereotypic behaviors: any physical movements that have indefinable characteristics of stereotypic behaviors including repeatability, self-stimulatory, contextual inappropriateness, and self-injuries.

7. Overlaps: observable similarities between two or more behaviors. Greater overlaps mean two behaviors have more identical components and therefore look similar. For example object tapping as a type of SB has some overlap with bouncing a ball in that both behaviors have similar hand motions even though the functions of the two behaviors are not identical.
Chapter 2: Literature Review

This chapter begins with an overview of etiology based on several related theories of stereotypic behaviors (SBs). A subsequent section focuses on the antecedent physical activity literature regarding types and intensities of physical activity, dependent variables, and functions of SBs. The final section provides a summary of the chapter.

Etiology and Related Theories

Various hypotheses and theories have emerged to explain SBs in relation to their cause and function. These hypotheses and theories have addressed neurobiological and non-neurobiological related factors.

*Neurobiological Factors*

Researchers have addressed SBs from both neurobiological and neurochemical perspectives such as hormonal level, brain function, and genetic problems. There is a significant body of research to support the notion that serotonin plays an important role in ASD-related behaviors such as social, repetitive and stereotyped behaviors as well as regulation and aggression. Researchers believe that serotonin level is related to brain development. Beginning with a study by Schain and Freedman (1961), there has been a line of research to examine the relationship between serotonin levels and SBs in individuals with ASDs. Investigators have found that participants with autism show
hyperserotonemia levels, which is an increased whole-blood serotonin (5-HT), compared to participants without autism. Even though there have been inconsistent results, serotonin levels may have some relation to ASD-related behaviors. Kolevzon et al. (2010) analyzed serotonin collected from 78 individuals affected with autism their ages ranged from 2 to 15 years old (mean = 6.77, SD = 2.93). Serotonin was correlated with ASD-related behaviors (e.g., restricted interests; repetitive motor stereotypes; and aggression). Several behavioral measures were used (i.e., Autism Diagnostic Interview-Revised [ADI-R], The Yale-Brown Obsessive-Compulsive Scale [YBOCS], and the Vineland Adaptive Behavior Scales [VABS]). Results indicate a significant inverse relationship between 5-HT and self-injurious behaviors (on the ADI-R); however no significant correlation with other ASD-related behaviors was found.

With regards to the potential function of serotonin in relation to ASD-linked behaviors, researchers have also conducted a generic analysis to test ASD susceptibility genes. The 5-HT transporter (SERT) gene is associated with blood 5-HT levels and ASD susceptibility; it enhances 5-HT clearance rate and in turn leads to hyperserotonemia.

Veenstra-Vanderweele et al., (2012) found that SERT Ala 56 mice exhibited ASD-associated deficits such as social and communication impairments and rigid compulsive behaviors. In particular they found decreased ultrasonic vocalization and repetitive behaviors such as climbing to and hanging from the cage lid in the SERT Ala 56 mice.

Opioid also has been regarded as a potential factor related to the self-injurious behaviors in autism (Campbell et al., 1993; Rojahn, Tasse, & Morin, 1998). Increased
opioid from the diet may interact with the CNS and in turn induce the behavioral features of autism. The precise mechanisms of opioid on the behaviors of autism remain unknown. However, it has shown that those with autism had β-Casemorphine-7, an opioid exclusively of dietary origin (Wakefield et al., 2002). In addition, reduced opioid intake (Wakefield et al., 2002; Whitely, Rogers, Savery, Shatock, 1999) or therapeutic trials using the oral opioid antagonist (Symons, Thompson, & Rodriguez, 2004) resulted in positive effects on autistic behavior such as repetitive, stereotyped behaviors, hyperactivity, and self-injurious behavior.

In addition to these neurochemical factors, structural problems in areas of the brain of individuals with ASDs have been implicated as a potential factor in SBs. Cerebellum and neuronal system abnormalities may be related to problems in sensory systems that can cause processing sensory stimuli problems and movement regulation problems (Courchesne et al., 1988).

It should be noted that almost all neurobiological and neurochemical research in ASDs has focused on animals. There are several advantages to using animal models in that identification of behavioral changes caused by genetic variation or hormonal changes is feasible. Direct approaches to identify the impacts of underlying changes in brain function or hormonal level on mouse behavior can promote an understanding of the behaviors observed in ASDs. Even though neurobiology and neurochemistry based research has provided scientific evidence on the etiology of behavior problems in ASDs, this research has also several limitations. Most limitations are based on the extent to which the findings from animal models of autism can be generalized. Difference in
mass/volume of relative structures between a human and an animal model may complicate findings. Moreover, the major problem for animal models is measurement validity of the SBs. In addition, animal model studies are highly expensive and require a high level of expertise.

*Nonbiological Factors*

Other researchers from a behavioral perspective attempt to explain SBs based on operant behaviors. These explanations are also called ‘non-biological theories’ as opposed to ‘biological theories’; however, they are not mutually exclusive.

*The perceptual reinforcement theory* (Lovaas, Newsom, & Hickman, 1987) argues that SBs are operant responses maintained by perceptual consequences. Therefore, they can be removed if the consequences are removed. The characteristics of SBs are manifest by its elaborative forms such as spinning or lining up objects and sensory stimuli created by the behaviors. The stimuli function as reinforcement which increases the likelihood of the same behavior occurring in the future.

SBs can also be explained by *a homeostatic mechanism* (Turner, 1999). This theory was originally addressed by Hutt and Hutt (1965, 1970) and Hutt, Hutt, Lee, and Ounsted (1964) based on the over-arousal hypothesis. This theory says SBs are a strategy to lessen or block excessive stimuli in the environment. From this theory, SBs are manifested by behaviors such as blocking ears to avoid noise or sound. The overarousal hypothesis suggests that an individual with ASDs may engage in SBs in order to regulate over or under stimulation of sensory inputs (Bodfish, Symons, Parker, & Lewis, 2000; Lovaas, Newsom, & Hickman, 1987). According to Dunn (1999, 2001), individuals with
ASDs respond differently to the same sensory stimulus due to a combination of different levels of sensory thresholds and responding strategies (passive or active). Based on Dunn’s conceptualization, an individual’s SBs (whether sensory seeking or avoiding) should be identified based on the person’s sensitivity to a particular sensory stimulus and tolerance level. Several studies report the effects of sensory interventions that decrease SBs by providing tasks matching the sensory consequences which maintain them (Piazza, Adelinis, Hanley, Goh, & Delia, 2000; Luiselli, Ricciardi, Schmidt, & Tarr, 2004; Patel, Carr, Kim, Robles, & Eastridge, 2000; Roberts-Gwinn, Luiten, Derby, Johnson, & Weber, 2001). However, researchers have not been able to demonstrate if such matched stimuli actually existed.

Some researchers more comprehensively explain the etiology of SBs in ASD from contingency-based perspectives including a functional analysis perspective (Iwata, Dorsey, et al., 1982/1994), which emphasizes both social (e.g., social attention, escape from demands, tangible reinforcement) and automatic sensory consequences (seeking or avoiding sensory feedback under-or over-stimulating situations) (Bright, Bittick, & Fleeman, 1981; Storey et al., 1984). An individual may engage in SBs to gain automatic reinforcement (self-stimulatory behaviors) but also to escape or avoid certain situations or tasks. For example, Durad and Carr (1987) analyzed the effects of various environmental contingencies on SBs in four children with pervasive developmental disorders. They demonstrated that the SBs of children increased when more difficult tasks were given. This study shows that some SBs are contingent upon social consequences such as task demands.
As an extension of reinforcement theory, communication-based theory views SBs as means to communicate needs. Since individuals with ASDs tend to have language impairments, they use SBs as a form of compensation. Volkmar and Lord (1998) reported that SBs are associated with cognitive levels and Matson, Rush et al. (1996) showed that higher levels of SBs were found in individuals with a dual diagnosis of profound intellectual disabilities and autism. Whether SBs are automatically reinforced (self-stimulatory behavior) or socially reinforced, an individual’s characteristics in relation to sensory processing and preference on task may affect SBs.

Antecedent Physical Activity Interventions for SBs

A substantial number of research studies have been dedicated to describing and measuring SBs in individuals with ASD. Different intervention approaches have been used to reduce SBs. One of the lines of research begun in order to understand the nature of stereotypic responding is the use of antecedent events by assessing the effects of manipulation in antecedent stimuli on the subsequent stereotypic responding. Physical activity has been investigated as a way of manipulating antecedent events and has shown positive results; however, there also have also been inconsistent findings. Researchers have attempted to find the most effective types, intensities, durations, and frequencies of physical activity with regards to decreasing SBs and maximizing appropriate responding.

Exercise Intensity

A study by Baumeister and MacLean (1984) used two different levels of exercise intensity in an attempt to identify potential fatigue effects on self-injurious and stereotypic behaviors. Participants were two healthy, compliant and nonaggressive adults
(27 and 19 years old) with intellectual disabilities. Jogging was selected as a type of exercise for the intervention and its distance was manipulated. One hour jogging every afternoon from 1-2pm was implemented for six weeks. During the first two weeks, the participant jogged one mile and two miles for the second two weeks. Finally they jogged for three miles during the last two weeks. Stereotyped movement, pacing, and social interaction were observed and the occurrences of those behaviors in percentages using 30-sec intervals. These observations occurred for in the morning from 9-10am, before the exercise and from 3-4 pm, after the exercise. The results reveal that the target behaviors gradually decreased over the course of the exercise program. The researchers interpreted that reduced target behaviors in the afternoon reflect fatigue especially after 3-mile jogging. However, decreases in one of the participants’ self-injurious and stereotypic behaviors during the morning might have resulted in exercise effects without fatigue. Therefore, this study shows inconsistent results regarding the effects of different levels of exercise based on the jogging distance and the influence of fatigue. This might have been caused by the implementation of the exercise program that was not based on the individual’s physical fitness and motor ability. The various jogging distances may have produced different lengths of activity time or a different pace. In addition, the behaviors of the participants were not observed right before and right after exercise. Because adults with intellectual disability were used in the study, the results may not be applicable to children with ASDs.

Celiberti et al., (1997) conducted a study to examine the effects of two levels of exercise intensity on maladaptive behaviors of a 5-year-boy with autism. They used 6-
minute jogging and 6-minute walking as the two levels of independent variables. Three target behaviors were selected: a) physical stereotypy (e.g., hand flapping and finger twirling), b) visual self-stimulation (e.g., eye gazing and squinting), and c) out of seat behavior. Data collection was conducted using a 10 second interval sampling procedure for the physical stereotypy and visual self-stimulation while a frequency count was used for the out of seat behavior. Three baseline observations were held prior to the onset of the interventions. An A-B-A-B design was used with 2-3 sessions of jogging (A) or walking (B) and each exercise condition was followed by a 40 minute-academic session right after a 3-minute post exercise break. Post exercise observations were conducted using a 10-sec interval for 4 consecutive 10-min time blocks. The results indicated that a jogging session reduced physical stereotypy and out-of-seat behavior, whereas a walking session did not produce any decrease in these behaviors. Reduction in visual stimulation was neither observed in the jogging condition nor in the walking condition. More apparent decreases were observed during the first 10-minute block after a jogging condition than the later three 10-minute blocks. This implies temporal effects of the jogging exercise. Even though this study used a functional assessment, the functions of the participants’ maladaptive behaviors were not clearly defined due to the absence of functional analysis. Despite the use of two different intensities of jogging and walking were not systematically controlled.

Levinson and Reid (1993) also investigated the effects of different intensities of physical exercise on stereotypic behaviors using jogging and walking. Three 11-year old participants with autism, two males and one female, participated in two exercise
programs which consisted of 15-minutes of walking and 15-minutes of jogging. The stereotypic behaviors of the participants were categorized into three different types: 1) motor (e.g., body rocking, flapping of hands, and kicking), 2) vocal/oral (e.g., screaming, laughing, and repetition of words), and 3) other. A 15-s interval sampling procedure with a cyclical pattern was used to measure the occurrence and the frequency of stereotypic behaviors by videotaping each individual for 1 min. Stereotypic behavior was measured prior to exercise, immediately following exercise, and 90 min following exercise. The 9-week investigation consisted of three phases: 1) The first baseline phase which consisted of three 2-hr observation periods in the classroom environment for two weeks prior to the onset of the intervention and after the termination of the intervention, 2) The second phase consisting of the two experimental conditions (a jogging session and a walking session alternately once a week) for 5 weeks. The intensity of the exercise was based on the subjects' heart rates, and 3) A final observation phase for which lasted approximately 30 min, 1-1.5 hr following the initial implementation of the treatment. During phase two, target behaviors were observed for a 45-minute period both pre-and post-exercise. Results indicated a significantly decrease (about 17%) in stereotypic behaviors only after a jogging session. A temporary effect of exercise was observed because the behaviors tended to return to pre-exercise levels 90 min after the exercise.

Kern, Koegel and Dunlap (1984) compared a vigorous and continuous type exercise with a less vigorous exercise to determine if one type of exercise is better in suppressing stereotypic behavior than another. In this study, unlike previous studies using jogging versus walking comparisons, ball playing was used as a type of less intense
physical activity than jogging. Three children with autism (age range 7-11 years old) participated in two types of activities- jogging and ball-playing. An alternating treatments design was used. The jogging pace was considered of mild intensity and therefore a temporary walk was allowed. The ball playing was tossing a soft rubber ball to the child from an approximately 2- to 3-meter distance, 10-20 times per minute. Positive verbal reinforcement was used to reinforce the running and correct ball playing behaviors.

Following a 1-hour baseline observation, each participant engaged in either 15-minutes of jogging or 15-minutes of ball playing in a large open field. The participants’ behaviors were observed for a 90-minute period in a furnished living room right after one activity and then engaged in another 15 minutes of the alternate type of exercise followed by another 90-minute observational period in the living room. The order of exercise was alternately balanced across days and children. A time sampling recording procedure was used with a 5-sec observation and 10-sec recording scheme. The results of the study indicate a decrease in SBs as a result of the jogging sessions while no such decreases were observed following the ball playing sessions. However, the possible fatigue mechanism was not experimentally explained. In fact, the assumption of this study that jogging is automatically more vigorous than ball playing was not based on any measures.

Prupas and Reid (2001) used frequency of exercise as a means to manipulate exercise intensity. Participation in several exercise periods throughout the day was used to determine the influence of exercise frequency on the stereotypic behaviors of four children with developmental disabilities (age range 5-9 years old). After four days of baseline observations which consisted of a 15-min observation per session in free play,
semi-structured and structured environment, two treatment conditions were implemented with 15-minutes of pre-and post-exercise observations. SBs of the participants were observed using a 15-sec interval-sampling procedure. During the treatment conditions, two different frequencies of exercise were implemented, both aimed at an intensity of 65-70% of the maximum heart rates. A pedometer was used to estimate the distance covered by participants. The single frequency exercise treatment consisted of one daily 10-minute walking/jogging session while the multiple frequency treatment involved three daily 10-minute walking/jogging sessions. The maintenance phase was a week after the participants experienced both exercise conditions over three separate days. A total percentage of time engaged in SBs showed 51.6% of the total mean reduction for all subjects in the single frequency sessions and 58.9% reduction in the multiple frequency sessions. These positive results were short-lived. Fewer SBs were observed when the post-exercise condition was combined with the classroom environment. This means that a more structured environment can contribute to the decrease of SBs. One of the limitations of this study was that there were no formal measures of the heart rates to assess the intensity of the two exercise treatments (aimed to 65-70% of the maximum heart rates).

In summary, studies using different physical activity intensities have been conducted using different frequencies, distances, and vigorousness. In general, the type of activities used in this line of research was mostly ‘jogging.’

*Appropriate Responding and Academic Performance*

Researchers have also investigated an inverse relationship between SBs and appropriate responding. They have attempted to determine if decreased SBs could be
linked to increased appropriate responding. Appropriate responding was measured by various measures such as increased correct academic responding, engagement time, and on-task behaviors. Researchers have also been concerned with potential negative effect of exercise such as fatigue that may negatively impact other responding especially positive responses.

A study by Rosenthal-Malek and Mitchell (1997) examined the effects of aerobic physical activity on the self-stimulatory behaviors and academic performance of five adolescents with autism (mean age=15 yrs old). They also assessed the generalization effects of aerobic activity on task performance in a community based workshop situation. Two pre-conditions, an exercise pre-condition and an academic pre-condition, were used and each condition was followed by either an academic condition or a community workshop condition. An exercise pre-condition was held in a gym using a combination of warm-up stretches and a mild intensity jogging exercise which lasted for 20 minutes. An academic pre-condition was delivered in classrooms where the participants engaged in various academic subjects and activities. A total of 10 academic and 10 physical activity pre-conditions were implemented ranging from 1 to 5 preconditions per week and arranged in randomized order. Each student’s stimulatory behaviors were randomly observed for 5 seconds in a cyclical way until all 5 participants were observed 10 times in each condition. During academic sessions, 10 questions were asked to each participant and correct academic responding was tallied. Task completion was assessed in the community workshop sessions by tallying the number of tasks correctly completed. Both t-test and visual analysis were used to analyze the data. There was a significant reduction
in self-stimulatory behaviors following the physical activity pre-condition as compared to
the academic pre-condition. In addition, the level of correct responding and work
completion significantly increased following the physical activity pre-condition.

Watters and Watters (1980) conducted a study to demonstrate the effects of an
antecedent physical exercise intervention on self-stimulatory behavior. They were
interested in determining whether decreased self-stimulatory behavior would be
accompanied by decreases in other types of behaviors such as appropriate responding.
They used a television pre-condition, which consisted of watching a 10-15 minute
duration of “Sesame Street,” to determine if any changes could occur due to changes in
regular schedules. In addition an academic work pre-condition served as a controlled
condition. Five boys (9.5 and 11.7 years old) in a school setting participated in the study
using group language training. They were observed to analyze the effect of antecedent
exercise on academic performance as well as on non-vocal self-stimulatory behaviors that
were individually defined. The exercise intervention used 8-10 minutes of jogging and
was composed of 27 sessions, 1-4 sessions per week with no more than 1 session per day.
The language sessions were followed immediately by one of three random pre-
conditions. Results reveal that the antecedent jogging decreased self-stimulatory
behaviors of the participants with a mean reduction of 32.7%. The effects of physical
activity were obvious because of no differences in percent self-stimulatory behaviors
followed by the television and academic pre-conditions were observed. Therefore, the
changes were not due to academic routine change. Even though they could not
demonstrate any positive changes in academic performance when physical activity was
provided, no differences in academic performance among three pre-conditions could be interpreted as decreased self-stimulatory behavior following physical exercise was not accompanied by a decrease in critical behaviors. This means physical exercise can be used as an effective way to eliminate self-stimulatory behavior in educational settings.

Kern, Koegel, Dyer, et al., (1982) investigated the effects of physical exercise on self-stimulatory behaviors and appropriate responding in children with autism (age range 5-7.6 years old for the first part of the study; and 9.2-14.6 years old for the second part of the study). Jogging was used as an antecedent physical activity during the participants’ recess time. The jogging was considered of mild intensity with a 5 minute length initially and a 20 minute length later in the study. The first portion of this study measured self-stimulation, ball-playing, and academic responding while the second portion measured on-task (sitting quietly, looking at the teacher or classroom materials, following directions) and off-task behaviors (self-stimulation, leaving the chair without permission, aggression, screaming). A repeated-reversal design was implemented. This involved 45 reversals between pre-and post-jogging sessions during 21 days of data collection. The results show a marked decrease in self-stimulation of the participants following jogging. Classroom data also revealed higher levels of participants’ on-task behavior following jogging sessions. There was an inverse relation between self-stimulation and appropriate responding; self-stimulation always decreased when increased appropriate responding was observed. The researchers mentioned that jogging might have a direct impact on the self-stimulation of the participants so that increased appropriate responding followed. Again, a potential utilization of physical exercise which would be effective in educational
programs and future curriculum development using systematic programming of physical activity into students’ daily schedule were recommended.

A study by Oriel, George, Peckus, and Semon (2011) is particularly intriguing because young children with ASDs participated in the study based on the notion that physical activity was important for these individuals. Using a within-subjects crossover design, a treatment condition and a control condition were implemented across four early intervention classrooms to determine whether antecedent aerobic exercise would improve academic performance and engagement and reduce stereotypic behaviors in young children with ASDs. Either a treatment or a controlled condition was implemented at random for 2 classes over 3 weeks. Percentages of correct and incorrect academic responses, on-task behaviors and stereotypic behaviors during classroom activities of nine young children, 7 males and 2 females between 3-6 years old (mean age: 5.2 years) were observed after either a treatment condition which consisted of a 15 min running/jogging exercise or a controlled condition in which no exercise was held before participation in a classroom task. A nonparametric statistical analysis indicated correct responding (p < .05) in seven of the nine participants following the exercise condition (71.49 in control conditions versus 82.57 in treatment conditions). However, no significant differences were observed for both on-task behavior and stereotypic behavior between the two conditions. Despite non-significance, visual analysis of the data reveal improvement in on-task time for five of the nine participants and decreased stereotypic behavior in four of the nine participants following the exercise condition.
In general, reduced SBs brought in by antecedent physical activity have been a positive influence on academic responding, appropriate responding, and academic engagement. Researchers view academic engagement time as a critical component of learning (Greenwood, Horton, & Utley, 2002) assuming increased engagement time during instruction is more likely to increase opportunities to respond and, in turn, enhance the achievement (DiPerna, Volpe, & Elliott, 2002). These findings are applicable not only to academic tasks but also to other tasks such as play skills, interactive tasks, motor skills, and daily life skills.

**Other Types of Physical Activities**

In addition to jogging and walking, researchers have used other types of physical activities to reduce SBs. Elliott, Dobbin, et al. (1994) compared a vigorous aerobic physical activity with a general motor activity. A one-factor repeated measures design was used to examine the effects of the two different types of antecedent physical activity conditions on maladaptive and stereotypic behaviors in six adults with autism, 3 males and 3 females, mean age of 30.8 years. Each participant’s heart rates and target behaviors were observed for 30 minutes in a controlled environment before and after each treatment condition. The participants were randomly assigned into one of three conditions: 1) a 20 minute non-physical activity condition (self-selected tabletop activities, no elevation of heart rates), 2) a 20 minute general motor training activity condition (90-120 heart rates/min. Activity examples include riding an exercise bike, using a stair-stepper, lifting light weights, and walking on a motorized treadmill at 2 miles/hr), and 3) a 20 minute vigorous, aerobic exercise condition (above 130 heart rates/min on a motorized treadmill).
moving at 4 miles/hr). The heart rates were measured before and after each physical activity condition. For target behavior, pre and post treatment condition observations were held for 30 minutes. Each participant experienced five sessions of each condition. There was a minimum 48-hour inter-session interval between conditions. Chi-square analysis was conducted on the proportion of behavior for the three conditions. Chi-square analysis revealed significantly improved behavior following the vigorous, aerobic exercise when compared to the non-physical activity condition (p< .001). Even though the general motor activity condition was shown as not producing any significant changes compared to either aerobic or non-physical activity conditions, three of the six participants showed a significant reduction in target behaviors (p< .005) after the vigorous, aerobic exercise condition. Overall, the vigorous, aerobic exercise resulted in 57% of maladaptive and 65% of stereotypic behavior improvement. A positive relationship between antecedent aerobic exercise and vocational tasks of the participants was informally reported. No participants showed poorer behavior after antecedent aerobic exercise; therefore, the vigorous, aerobic exercise can be used as a part of individualized behavioral programming and be a useful tool for facilitating community integration for adults with ASDs. Even though this study used a formal physiological measure (heart rates), the heart rates were not measured during each condition. In addition, the intensity levels such as “above 130 heart rates/min” and “a motorized treadmill moving at 4 miles/hr for all” seem somewhat contradictory. This study differentiated the three experimental conditions only by heart rates not by kinds of activities. Therefore, there was no clear definition among general motor training and vigorous, aerobic exercise
other than heart rates. Furthermore, how target behaviors were observed and the definitions of maladaptive and SBs were not clearly stated in this study.

Power et al. (1992) used roller-skating instead of jogging or walking. The type of antecedent exercise was a 10-minute roller-skating activity. Its effects on self-stimulatory and on-task behaviors were examined with regards to an 8-year-old boy with developmental disabilities. A partial-interval time sampling was employed using a 2 min interval for a period of 30 minutes during the participant’s leisure session; any occurrence of self-stimulatory behaviors was recorded within an interval. On task-behaviors were recorded at the end of each of the 2 minute interval using 1-min intervals during the first 15 minute of the 30 minute observation. During the antecedent condition, the participants engaged in roller-skating 10 min prior to the structured leisure session. An ABAB reversal design was used with 1) a baseline condition (A: Day 1-9), 2) an antecedent roller skating condition (B: Day 10-15), 3) a second baseline condition (A: Day 16-26), and 4) a second antecedent roller skating condition (B: Day 27-37). Results indicate a decrease in self-stimulatory behavior (a mean of 19-22%) and a corresponding increase in on-task behaviors (a mean of 46-75%) during the intervention conditions.

Cannella-Malone et al. (2011) used multiple physical activity components forming a physical activity routine which consists of various motor tasks such as running, jumping, yoga poses, scooting, jump roping, and stretches to examine whether or not the use of an antecedent physical activity routine across the day would reduce challenging behaviors to zero or near-zero levels and reductions in behavior can be generalized across all school environments and activities. Three participants, ages 8, 9, and 11 years old,
below 70 IQ, in a special needs elementary school participated in this study. Challenging behaviors included aggression (e.g., hitting, kicking, yelling, spitting), property destruction (e.g., throwing), and other inappropriate behaviors such as inappropriate sexual behavior. A multiple-baseline across participants design was used. Since this study was a part of another larger study which conducted a functional assessment, the information on the function of frequent challenging behaviors of the three participants, which were escape-maintained, was provided. The frequency of challenging behaviors was recorded by the classroom teacher during the entire school day using 1-hour intervals. The intervention package consisted of two 20-min exercise routines and six 1-to 5-min exercise breaks every hour. Total physical activity averaged from 20 to 40 minutes each day and consisted of mostly moderate physical activity. When the students arrived at school, they engaged in a 20-min physical activity routine and another physical activity routine immediately following lunch. Between the physical activity routines, they engaged in a 1-to 5-min physical activity break every hour from 8am to 3pm, a total of 6 times. There was a chart condition in which a sticker was given for activity participation. Up to 8 stickers per day could be given and once the chart was filled with 30 stickers, a small prize from the classroom prize bag was chosen by the participant. There was a preference condition in which the participants were allowed to choose their physical activity only during the six physical activity breaks. The intervention procedures followed: 1) baseline, 2) intervention (physical activity routines, physical activity breaks, and chart), 3) add choice (during physical activity breaks), 4) no chart, and 5) follow-up. The results show positive effects of antecedent physical activity eight times across the
school day on challenging behaviors eventually decreasing them to zero or near-zero levels. When a choice of physical activity was given, all participants exhibited lower or similar levels of challenging behavior compared to non-choice conditions. Generalization was naturally programmed into the intervention because the entire school day and various settings were used. This study implies the use of frequent physical activity sessions throughout the school day and across school environments can be socially acceptable to the teachers implementing the intervention. However, the length of each physical activity break that the students engaged in might have varied from 1 to 5 minutes in duration per break. It is unclear whether physical activity breaks that were repeated every hour provided the students with more flexibility in their schedules causing challenging behaviors that were maintained by escape contingency to decrease. Any differences were observed when various frequencies of physical activity sessions per day were implemented. In fact, packaging different kinds of physical activity makes it hard to see the effects of an individual type of physical activity on SBs. Lastly only frequency counts for the target behaviors were used, but how long and how severe each behavior occurred was not evaluated.

Several studies examined the effect of different types of physical activity other than jogging or walking on SBs. In addition to aforementioned studies, there are studies reporting the effect of aquatic activities on children with ASDs’ stereotypic behaviors (Yilmaz, Yanardag, Birkan, & Bumin, 2004; Bumin et al., 2003). Aquatic activities are regarded as ideal for children with ASDs because of health benefits, age appropriateness, and social skill development (Rogers, Hemmeter, & Wolery, 2010; Pan, 2010). Both
health benefits and skill learning have been reported from the use of aquatic environments for children with ASD including water orientation skills (Huetig & Darden-Melton, 2004), basic swimming skills (Fragala-Pinkham, Haley, & O'Neil, 2011), aquatic play skills (Yılmaz, Birkan, Konukman, & Erkan, 2005) and fitness-related health (Yılmaz, Yanardag, et al., 2004). More studies need to be conducted to examine the effects of physical activities on SBs and other subsequent appropriate responding using other types of physical activities in order to provide more opportunities for children with ASDs to participate in various types of physical activities to intervene their SBs.

Hypothetical Mechanisms of Physical Activities

*Matched Stimuli*

Antecedent manipulation has been used for reducing SBs (Rapp & Vollmer, 2005). Researchers using antecedent manipulation interventions believed that manipulating antecedent events might influence the occurrence of SBs based on the notion that the environment may produce an alternative or replaceable response for SBs. Environmental enrichment (Piazza et al., 2000) and providing competing or substitutable stimuli (LeBlanc, Patel, & Carr, 2000) are all interrelated methods for reducing SBs. The notion of antecedent manipulations is based on motivating operations (Michael, 2007) that explain a motivation operation as key to altering some stimuli and frequency of behaviors following antecedent stimuli. A motivating operation is often related to an increased or decreased in the effectiveness of an intervention (Vollmer, 1994). This assumption led researchers of antecedent physical activity interventions to believe that physical activities, especially with vigorous intensity, can provide participants matched
stimuli to match their sensory needs. Low environmental stimulation often causes SBs (Piazza et al., 2000; Rapp, 2005; Repp, Felce, & Barton, 1988). Environmental enrichment involves manipulating antecedent variables to provide potentially competing stimuli with the concurrently available functional reinforcer (LeBlanc et al., 2000). Therefore, the function of environment enrichment is to create an abolishing operation reducing the efficacy reinforcement that maintains SBs.

Piazza et al. (2000) evaluated the effects of providing continuous access to items that produce similar sensory consequences to those of problem behaviors. Three children with developmental disabilities with problem behaviors which were automatically reinforced participated in the study. In order to identify leisure items that matched and did not match the sensory consequences of the problem behaviors, preference assessments were conducted. Each participant was allowed to freely and continuously access to either highly preferred ‘matched’ or highly preferred ‘unmatched’ items. Results show that matched items were more effective in reducing problem behavior than unmatched items. Based on the results, Piazza et al. (2000) suggested that decreases in problem behaviors in their study accounted for abolishing operation when the matched items continually provided preferred sensory reinforcement. By contrast, deprivation of the sensory stimuli resulted when the participants were provided unmatched stimuli. Similarly, a study conducted by Rapp (2007) examined the effect of matched stimulation to decrease automatically reinforced behaviors in 9-year-old boys diagnosed with autism. The differential effects of both matched and unmatched stimulation were examined using leisure items that produced auditory stimulation. The items provide auditory stimulation
with a similar sensory consequence maintaining vocal stereotypy. The results indicate lower levels of SBs when matched stimulation was given.

Levinson and Reid (1993) and Morrison, Roscoe, and Atwell (2011) explained the effectiveness of antecedent physical activities based on this conceptualization on matched stimulation. They argued that decreases in SBs were found when the sensory stimulation that maintained SBs was produced by participation in physical activities.

One of the weaknesses of this explanation is uncertainty as to whether the decreased SBs were primarily due to matched stimuli or simply preference. For example, a study by Ahearn, Clark, Debar, and Florentino (2005) showed that some activities that did not provide the same sensory stimulation produced by SBs also effectively decreased SBs. They pointed out that SBs could be decreased when stimulations compete against each other and greater preference for other forms of stimulation (unmatched) were found. Ahearn, Clark, Debar, and Florentino (2005) suggested the possibility of reducing automatically reinforced SBs using alternative form of competing stimulation that do not match to the stimulation produced by SBs. (e.g., Vollmer, Marcus, & LeBlanc, 1994).

Another weakness is that there has been limited evidence of whether reductions in automatically reinforced SBs are resultants of stimulus competition (Rapp, 2007) or stimulus substitution (LeBlanc et al., 2000). Providing physical activity can either temporarily suppress SBs or provide matched stimulation for the SBs. In addition, the definition of matched stimulation provided by alternative activities or items relies on overt characteristics of the SBs. This provides researchers difficulty in explaining why unmatched stimulation enables the decrease SBs.
Hypotheses relative to the effects of physical activities on SBs (maintained by automatic reinforcement) have led researchers to use physical activity interventions to identify the mechanisms of physical activity in reducing SBs.

Functions of SBs in Interventions

Even though most studies using antecedent physical activity interventions have reported positive results, only few studies used functional assessment or functional analysis to examine what contingencies maintain the target behaviors (i.e., Cannella-Malone et al., 2011; Morrison et al., 2011). It is imperative to understand the functions of SBs when implementing independent variables and also when interpreting the results. For example, if a participant’s SBs are maintained by escape-contingency, a non-preferred or demanding physical activity may result in increased SBs. Likewise, if the function of SBs is to get more attention, a physical activity intervention in which the participant receives continuous attention from the instructor or keeps active interaction with the instructor is likely to decrease the SBs. Depending on the function of the behavior, the efficacy of the given intervention may be effective or ineffective in decreasing targeted SBs. Larson and Miltenberger (1992) combined an antecedent physical activity condition with an attention control condition. They reported that neither the antecedent physical activity condition nor the attention control condition reduced problem behavior below the baseline levels. They concluded that only functional analysis can provide the maintaining variables of the participants’ target behaviors. Therefore, with the absence of functional analysis, it is difficult to predict the potential effects of the independent variables. In addition, depending on the activity preference of participants in the intervention, the given physical...
activity can be pleasant stimuli or aversive stimuli to the participants. Therefore, in order to avoid unwarranted effects caused by any aversive and demanding stimuli, preferred physical activities and participants’ ability to perform the physical activities must be taken into consideration.

Morrison et al. (2011) conducted a study based on limitations found in previous studies which used antecedent physical activity. The effects of antecedent physical activity on problem behaviors of four individuals with autism were found through a functional analysis. Four individuals with autism, ranging in age from 10-24 years old, served as participants. Their problem behaviors were stereotypic and self-injurious behaviors and identified through functional analysis as being maintained by automatic reinforcement. Therefore, the logic behind this study was that antecedent physical activity may be most effective when functioning as an abolishing operation for problem behavior maintained through automatic reinforcement. They conducted preference assessments to identify preferred leisure and physical activity items based on the assumption that engagement in preferred items would provide the participants with the matched stimulus they seek. Participants’ high levels of item engagement and low levels of problem behaviors determined preferred items during the preference assessment. Following the preference assessment, three consecutive test phases were used to examine the effects of the exercise intervention. The three phases allowed the researchers to analyze immediate and subsequent effects of the intervention by recording the target behaviors for 10 minutes before, during and after a 10-minute treatment comprised of either physical activity items, leisure items, or social attention. Since a physical activity
session itself is a combination of various natures such as enjoyment, attention, and social interaction, the researchers included a noncontingent leisure-item control condition and a social-interaction condition to see the separate effects of the different aspects of physical activity. During the preintervention and postintervention components, the participant was alone in the room with no materials. During physical activity-item and leisure-item intervention conditions, the participant had continuous access to the preferred items that had been identified during the preference assessment. Verbal and physical prompts for reinforcing the engagement with the items were provided and additional prompts and praise were used every 10 seconds. During the social-interaction intervention condition, no items were presented, and the therapist delivered attention on the same schedule as that used for prompts and praise during the physical activity- and leisure-item conditions. The results showed reduced problem behaviors during and after the antecedent physical activity. Similarly positive effects were found during the leisure item condition. These findings indicate that physical activities may be an appropriate treatment component for participants with problem behaviors maintained by automatic reinforcement because it may have either an abolishing effect or fatigue effect. One of the study participants showed lower levels of self-injurious behaviors during the post-intervention component for all of the assessments. Therefore, for this participant, it was difficult to interpret if the physical activity-item sequence had a singular effect of reducing the target behaviors. In addition, the study showed that not all physical activity items were equally preferred. Therefore, use of physical activities without consideration of preference might have been influenced by uncontrolled variables. However, the study could not determine if selected
items were familiar enough for the participants to play with them, if participants’ appropriate and inappropriate manipulation of those items were accounted for, or if the intensity of the physical activities were taken into account. Despite the limitations, the study has potential to contribute to future research by addressing improvement in design and treatment procedures.

Summary

SBs can be explained by both neurobiological and non-biological perspectives. Neurobiological studies suggest genetic problems or abnormality in brain structures. Non-biological studies view SBs as functions of social or sensory consequences. Studies have been conducted using different types, lengths, and intensities of physical activities to reduce SBs and increase task engagement in individuals with ASDs. Research results suggest that physical activity can decrease SBs; however, research on the effect of antecedent physical activity on SBs has been limited to aerobic activities as well as other types of physical activities such as jogging, walking and aquatics. Few studies have targeted SBs in young children and age-appropriate activities have not been taken into consideration. Finally, researchers suggest that identifying activity preferences and functions can contribute to a better understanding of SBs.
Chapter 3: Methods

This chapter contains the following six sections: (a) pilot study, (b) participants and setting, (c) experimental design (independent and dependent variables), (d) procedures, (e) treatment integrity and procedural reliability, and (f) data analysis.

Pilot Study

Two 8-year-old boys with ASDs exhibiting SBs served as participants. The purpose of the pilot study was to examine if two activity conditions (land-based; pool-based) were viable in reducing SBs in children with ASDs.

During a pre-baseline phase, each participant’s SBs were observed in a quiet room where neither activities nor equipment were provided. Target SBs were operationally defined for each participant. Then participants experienced two motor activity settings to identify preferred activities.

During the baseline phase, each participant’s SBs were observed under unstructured physical activity conditions in gymnasium and pool settings. During baseline, no instruction was given but participants had access to equipment. Baseline data collection continued until a stable pattern of responding was achieved. The investigator informally interacted with each participant individually every 10 seconds by asking gross motor related questions and other
informal questions (e.g., “Do you like soccer?”). This was done for providing attention or social interaction alike the participants had during the physical activity conditions.

During the treatment phase, both intervention conditions were alternated. The land-based condition included preferred locomotor (e.g., running, jumping) and object control activities (e.g., kicking, throwing, dribbling). The pool-based condition included preferred basic swimming and water orientation activities (e.g., kicking, blowing bubbles, back floating). To reduce an order effect, both land-based versus pool-based conditions were systematically counterbalanced across participants. Only one activity session was conducted per day. At the beginning of each session, the instructor provided a verbal prompt to perform each skill and then demonstrated it prior to each trial (e.g., “Now throw the ball toward the target (verbal prompt),” “Let me show you how to throw the ball. Step and throw overhand (demonstration).” Following the demonstration, a verbal prompt was given to engage in the skill (e.g., “Now it is your turn. Throw the ball toward this target”). If the participant did not follow the prompt within 5-seconds, a physical prompt (physical guidance) was given to guide the participant through the movement. Following the physical prompt another verbal prompt was given. If the participant performed the task, verbal praise was delivered within 3 seconds. During the pool-based instruction, the water was about chest deep so that the participants’ feet could touch the pool bottom. Activity sessions occurred two to three days a week and lasted 13-15 minutes (mean 14 minutes). During the last two sessions of each condition teacher praise was not delivered. This was to determine if there was a teacher praise effect on SBs. All sessions were videotaped and the percentage of time exhibiting SBs was calculated using a momentary time sampling procedure with 10-s intervals (Gardenier,
MacDonald, & Green, 2004). Interobserver agreement and treatment fidelity were established (93.5% and 95%, respectively) on 20% of randomly selected sessions.

The results showed marked SBs decreases for both participants across both settings. For the gymnasium, Participant A exhibited SBs ranged from 29.5% to 39.7% (mean=34.3%) during the baseline. His SBs during the activity ranged from 4.4% to 13.3% (mean=9.9%). For the pool, Participant A showed SBs ranged from 16.7% and 19.2% (mean=17.9%) during the baseline and from 3.9% to 7.3% (mean=6.2%) during the activity condition. Participant B’s % SBs in the gymnasium ranged from 29.5% to 59% (mean=49.1%) during the baseline and from 4.8% to 34.4% (mean=13.5%) during the gym activity. In the pool setting, Participant B exhibited SBs ranging from 30.8% to 51.5% (mean=37.5%) during the baseline and from 3.9% to 22.2% (mean=11.1%) during the pool activity. In general, low SBs were observed in the pool setting. Teacher praise did not affect SBs.

The pilot study demonstrated decreases in SBs during physical activity regardless of the types of activities. In addition, teacher prompts might have played a role in decreased SBs during physical activity, since higher levels of SBs were observed during the baseline phase where no teacher prompts were provided. Results suggest the importance of structured physical activity in reducing SBs.

Several limitations were noted. First, levels of SBs during the pre and post activity were not measured; therefore, it was not clear if physical activity sessions which consisted of preferred activity tasks with age appropriate equipment would have had an immediate effect on SBs. Second, even though the pilot study showed the effects of two types of physical
activities, the setting effects might have been in present. Even though it was obvious that both types of physical activities had a number of distinctive features, the relative effects on SBs were unable to be shown. Third, an analysis to identify the function of participants’ SBs (functional analysis) was not conducted. Thus, the interpretation of results was limited. Lastly, task engagement was not measured; therefore, an inverse relationship between SBs and on-task behavior could not be demonstrated.

As a result, the dissertation study was designed based on the results and limitations of the pilot study. First, a functional analysis of SBs was conducted in order to promote greater insight into the function of SBs. Second, one physical activity setting was composed of two types of activities- locomotor and object manipulation. The dissertation study aimed to provide two distinctive types of physical activity. To determine if the two types of physical activity differed in intensity, a heart rate monitor was used. Fourth, pre- and post-activity phases allowed one to observe SBs outside of actual physical activity performance and an immediate effect of physical activity. Fifth, both vocal and motor SBs were observed to see if both would respond differently to the physical activities. Finally on-task behavior was measured to determine relationships between SBs and task-engagement.

Participants and Setting

Participants

Participants were three preschool children (3-6 years old) diagnosed with an autism spectrum disorder (ASD) (*DSM IV-TR*, APA, 2000), who attend a preschool for individuals with and without ASDs. The three participants were selected based on high rates of restricted, repetitive, and stereotyped behaviors (SBs) reported by their teachers.
that interfered with their educational activities or social interactions. All participants had neither significant medical contraindications nor primary physical impairments that affected their participation. There were no standardized cognitive or gross motor scores available prior to the study because intellectual or psychomotor ability was not of interest.

Prior to the beginning of the study, an official approval letter from the participants’ preschool was obtained (Appendix A). The letter was used for the application to the Ohio State University Human Subjects Institutional Review Board (IRB). The IRB research forms were submitted and approval was obtained prior to the onset of the study (Appendix B). The investigator spent two weeks to select participants who might be eligible for the study and to build rapport with the potential participants. The classroom teachers were consulted to identify participants who might be suitable for the study (i.e., history of SBs). Following Board approval, a recruitment letter and parental consent form were sent home to potential participants (Appendix C). Parents and/or guardians interested in having their children involved in the study completed the permission forms and returned them to their child’s classroom teacher.

Participant 1 (Thomas) was a 3-year-old Caucasian male. He was considered non-verbal and communicated through alternative means such as the Picture Exchange Communication System (PECST™) but was able to model simple words such as “hi,” “bye,” etc. when multiple prompts were given. He sometimes repeated words such as “sailboats” while playing with blocks (half circle and a triangle) and “tissues” when he had runny nose. Thomas had shown good progress in following one-step routine
directions such as “line up,” “go to Circle,” etc. He was able to match puzzle pieces and put blocks together. His social interaction skill was minimal; he hardly initiated any types of social activities (e.g., conversation, physical contact, eye contact). He had a history of various problem behaviors that included SBs, physical aggression, self-injurious behaviors, and non-compliance. Teachers described his SBs occurring frequently during academic and free play situations. He liked wooden blocks and cars but often engaged in SBs using them. When Thomas got angry, he banged his head on the floor or hit his head with his fists. Those occurred frequently when he transitioned to the bathroom. The teachers had redirected his self-injurious behaviors to other appropriate behaviors or tried sensory blocking by covering his head with their palms to protect the head from banging or hitting. He liked running and jumping. He threw an object well without aiming at a specific target but most of time engaged with objects in an inappropriate way (e.g., grasping an object in hands for a long period of time or banging or tapping using an object).

Participant 2 (Aidan) was a six-year-old Caucasian male. He was able to mimic words and short phrases told by his teacher or to get what he wanted. He was able to correctly name objects in a book, match puzzle pieces, and put blocks together although he tended to show disinterest in puzzles and blocks. He sometimes asked for help, for example by touching teacher’s hand, when he encountered with a difficult task. He exhibited a severe level of verbal SBs. He ceaselessly made vocal sounds such as high-pitched shrieking, singing, and repetitive, or inappropriate speech to the circumstances such as ‘television talk.’ His teachers described his vocal SBs as severely disrupting his
academic time and interfering with his ability to paying attention. His motor competence
was relatively high. He jumped, ran, played with balls on a regular basis, but his SBs
often were accompanied with those activities. Aidan was easily distracted by his
environment (e.g., classroom decorations). But when multiple verbal and visual prompts
were given, he was able to: a) follow one-step routine directions, b) imitate a gesture or
action, and c) transition to or remain in a designated area for the duration of the activity.

Participant 3 (Blake) was a six-year-old Caucasian male. He was considered non-
verbal but able to vocalize (e.g., ‘ah,’ ‘da’) to express his needs for highly motivating
foods, toys, or objects. Blake had difficulties in match puzzle pieces so his classroom
teachers created color-matching tasks using laminated colored paper pieces. His fine
motor skill delays were also apparent in almost all class activities such as drawing,
coloring, cutting, matching, and putting blocks together. Blake had difficulty keeping his
body still and needed hand over hand adult help to complete object manipulation skills
(e.g., aiming, cutting, drawing). He was highly social and sought attention, help and
physical contact. He often made spontaneous loud and repetitive vocalizations and palatal
clicks. He was considered to have severe sensory processing issues according to his
classroom teachers and occupational therapists. He sometimes had a hard time controlling
his body. He would rub body parts (e.g., abdomen, back, private parts), constantly move
his body or waddle, or chew an object (e.g., a shirt sleeve). He sometimes exhibited
obsessive-compulsive behavior toward a particular object (e.g., spinning a wheel on a toy
truck for a long period of time) and got upset when the item was taken away. Blake
needed multiple verbal and physical prompts to attend to the task at hand and stay engaged in an activity for 2-3 minutes.

Setting

This study was conducted at a private preschool comprised of culturally diverse students and located in an urban area. The preschool classes operated 4 to 5 days per week during the school year. The students attended full-day or half-day sessions. The ratio of children with and without ASDs to was about 5 to 7. The school had a relatively low student-teacher ratio; a class had no more than 14 children, with one licensed lead-teacher and two qualified teacher assistants. The Letter People curriculum, a multi-model approach that incorporates music, puppets, visual aids, and hands-on activities to learn alphabet was the core curriculum model used in this preschool. The curriculum emphasized students’ pre-reading skill development. In addition, various instructional activities were used including dramatic play, story and boo time, fine and gross motor activities, tasks for developing problem solving skills, social interaction, and time management skills. A daily schedule included play, literacy time, motor and movement, music, and art. Learning activities in literacy, math, science, and social studies were embedded throughout playtime. In addition, in informal settings such as during music, playtime, and outside time, children’s fine and gross motor and imitative movement skills were also emphasized.

The preschool offered a comprehensive program for intellectual, language, gross and fine motor, and social-emotional development of children aged 3 through 6 years old. All classrooms used visual aids such as PECSTM. There were occupational therapy and
speech therapy rooms. All of the participants in this study were receiving an average of 30 minutes of occupational therapy and speech therapy per week. There was an outdoor playground with climbers, slides, tricycles, and a sand area. The children had two 15-minute outdoor recess times every school day except during extreme cold temperatures or inclement weather.

This study was conducted in the children’s regular school environment. However sessions were controlled (e.g., one-on-one interaction with the investigator). An empty classroom located on the basement level and typically used for after school programs was used for the study. The room looked identical to the participants’ classrooms. The investigator set up a desk and two chairs in the corner of the classroom for the preference assessment, functional analysis, and pre-and post-physical activity phases. Bookshelves surrounded the area to minimize distractions and to facilitate videotaping.

The physical activity intervention was conducted in the same classroom but outside of the area confined by the bookshelves. A large carpet in the classroom gave the participants a large space for safe physical activity. During the study no one other than the participant and investigator were in the classroom. Sessions for each participant were always held at the same time of day to minimize confounding variables or intrusions into regular classroom routines and schedules.

Experimental Design

A single subject, multielement design was used and based on Morrison et al. (2011). In a traditional multielement design, two or more independent variables are presented in an alternating sequence to individual participants. In this study, a
multielement design was selected to compare the effects of two types of physical activities (locomotor vs. object manipulation) on SBs. Morrison et al. (2011) used a three-component test sequence which consisted of a pre-intervention condition, a treatment condition, and a post-intervention condition. They stated that this test sequence allowed the investigator to observe the immediate and subsequent effects of a given intervention because the pre-intervention condition served as baseline. Therefore, this study attempted to use this three-component test sequence with a shorter length of each phase, considering attention span of preschoolers with ASDs.

Pre-physical Activity and Post-physical Activity Phases

The physical intervention part of this study used a three-component test sequence that was comprised of a 5-min of pre-physical activity (Pre-PA) phase, a 5-min of physical activity (PA) phase that would include either locomotor (LC) activity or object manipulation (OM) activity, and a 5-min of post-physical activity (Post-PA) phase that was identical to Pre-PA. During the Pre-PA and Post-PA phases, the participant’s four preferred play items were provided and they had free access to them for 5 minutes. The play items were selected through a preference assessment. A highly preferred item which was used by the participants only to engage in SBs was excluded. A list of play items for each participant can be found in Appendix D.

The investigator presented all items together and encouraged the participant to play with the items saying, “Look, (name). You have (pointing to each item) (name of item 1), (name of item 2), (name of item 3), and (name of item 4). You can play with any of these. Let’s play.” When the participant made a choice to play with an item, the investigator
said, “Good, you selected (name of item). Don’t forget you have other toys here. You can play with them too,” and kept encouraging his play. When the participant stopped playing with the item, the investigator directed him to select another item saying, “Oh, are you done? Let’s see..., you still have (pointing to each item) (name of item), (name of item), and (name of item). Choose one. Let’s play.” Additional prompts or praise were provided every 10 s while the participant was playing. When the participant started engaging in SBs or exhibited challenging behaviors, general prompts were still provided every 10-s to redirect him using the above statement.

Independent Variables

The independent variables for this study were two types of physical activities that included age appropriate LC and OM activities. During PA, the participant engaged in various age appropriate LC or OM activities that incorporated developmentally appropriate items (i.e., trampoline, balls). The activities were selected based on the participants’ occupational therapists and classroom teachers’ opinions as well as the researcher’s judgments. The teachers provided a list of possible activities because two of the three participants had been known to have limited gross motor ability. The investigator made several physical activity suggestions. The most appropriate physical activities and items for each participant were determined. A list of LC and OM activities for each participant can be found in Appendix E.

Locomotor Activities

Various LC activities were selected in order to increase heart rates. They involved large muscle activities such as running, jumping, wheelbarrow walking (walking on
hands with the legs up high held by the investigator) and crawling. Since the classroom was relatively small, participants ran 2-3 laps using a hallway outside of the classroom as well as climbing up and down stairs.

Object Manipulation Activities

Various OM activities were selected including throwing, catching, rolling, bouncing, and placing objects into baskets. Age appropriate items such as balls with various sizes, colors, and textures, bowling pins, a mini basketball hoop, bean bags, balloons, and a foam disc were used. During OM activities, participants were allowed to have continuous access to the PA items and the investigator continuously presented an item or handed the item to them. OM activities were considered much more sedentary than LC activities but the investigator did not restrict jumping or moving around during the OM activities.

Dependent Variables

Stereotypic Behaviors

SBs served as the primary dependent variable. Before the onset of the study, SBs of each participant were operationally defined and described. Topographies of SBs were also confirmed by the classroom teachers. SBs included both motor and vocal SBs.

Target SBs of Participant 1 (Thomas) included both motor and vocal SBs. Table 3.1 provides the definitions for Thomas’ SBs. His primary SB was drumming which included a tapping or wiping motion of his hand(s) on his body or desk with or without an object. His teachers also commented on his staring (e.g., staring at an object or a place out of the corner of the eyes). His staring behavior sometimes involved manipulation of
eyelids with fingers. To minimize subjectivity in the coding procedure, general staring behavior without eyelid manipulation was not coded.

<table>
<thead>
<tr>
<th>Stereotypic Behaviors</th>
<th>Definitions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Drumming</td>
<td>Hitting or tapping self or an object or surface with or without objects using the palm(s) or finger(s) more than two consecutive times; Slapping the arm(s) against the body, an object, or surface</td>
</tr>
<tr>
<td>Staring</td>
<td>Staring at an object or a place, rubbing the eyes more than twice, manipulating eyelids with fingers; Staring at an object, placing the object right in front of nose (less than 5 inches away from his eyes)</td>
</tr>
<tr>
<td>Vocal Stereotypic</td>
<td>Vocalization (words, babbling) more than three times or longer than 2 seconds; High pitched shrieking</td>
</tr>
<tr>
<td>Behaviors</td>
<td>Hand(s) at head or shoulder level and waving them rapidly (floppy motion)</td>
</tr>
<tr>
<td>Flapping and</td>
<td>Swaying body or head side to side or back and forth more than two consecutive times; Shaking head or spinning head more than two complete cycles.</td>
</tr>
<tr>
<td>clapping hands</td>
<td></td>
</tr>
<tr>
<td>Body rocking</td>
<td></td>
</tr>
</tbody>
</table>

Table 3.1. Thomas’ Stereotypic Behaviors and Definitions.

The primary target SBs of Participant 2 (Aidan) were vocal. Table 3.2 provides definitions for all of Aidan’s vocal and motor SBs. Aidan constantly made babbling, singing, and shrieking sounds. Unlike the coding procedures for other participants’ vocal SBs, his singing was considered a SB, because singing was a major SB interfering with his academic work. His teachers intervened when his vocal and motor SBs took place during academic work. He tapped his chin or mouth using his hand(s) and bumped his chin or mouth against another person’s body part (e.g., the investigator’s arm or hand). He was physically active, constantly jumping up and down. His jumping up and down or pressing his body on furniture was often accompanied by his vocal SBs.
Participant 3 (Blake) engaged in vocal and motor SBs. Table 3.3 provides the definitions for Blake’s SBs. His vocal SBs consisted of spontaneous loud sounds, repetitive vocalizations, and tongue clicking. He had a wide variety of SBs and occurrence rates varied greatly across days. His teachers sometimes communicated with him using pictures in order to redirect or intervene with his SBs. His teachers reported poor motor planning skills and difficulty in sensory processing. Blake often put things in his mouth such as his shirtsleeve, fingers, or toys. He banged objects with his head and hands and it seemed to provide him auditory stimulation. He seemed to want to have constant sensory input by rubbing his body part against objects, furniture, or the floor; his teachers often said “Blake, sit up and calm your body.” Since he vocalized to express his feelings or desires, his functional vocalizations were not considered as a SB. For example, when the investigator greeted him by saying “Hi, Blake.” and he responded by making an “ah” sound.

<table>
<thead>
<tr>
<th>Stereotypic Behaviors</th>
<th>Definitions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Vocal Stereotypic Behaviors</td>
<td>Singing, babbling, repetitive production of non-contextual words and phrases; Repetitive production of contextual words and phrase more than three consecutive times; High pitched shrieking</td>
</tr>
<tr>
<td>Tapping</td>
<td>Any object, hand, or arm that came in contact with his chin or mouth more than two repetitions.</td>
</tr>
<tr>
<td>Bouncing</td>
<td>Jumping, pressing his body on furniture (and kicking his legs up and down)</td>
</tr>
</tbody>
</table>

Table 3.2. Aidan’s Stereotypic Behaviors and Definitions
<table>
<thead>
<tr>
<th>Stereotypic Behaviors</th>
<th>Definitions</th>
</tr>
</thead>
<tbody>
<tr>
<td>Rubbing</td>
<td>Rubs hands or objects on the body back and forth more than two consecutive times; Placing his back on the floor and moving body to rub the back</td>
</tr>
<tr>
<td>Vocal Stereotypic</td>
<td>Repetitive production of sounds (e.g., “ah-da-da-da”); Clicking tongue more than three consecutive times</td>
</tr>
<tr>
<td>Behaviors</td>
<td>High pitched or loud shrieking</td>
</tr>
<tr>
<td>Flapping</td>
<td>Hand(s) at head or shoulder level and wave them rapidly</td>
</tr>
<tr>
<td></td>
<td>Pumping his arms rapidly</td>
</tr>
<tr>
<td>Mouthing</td>
<td>Licking an object; Putting an object or finger in his mouth; Chewing an object</td>
</tr>
<tr>
<td>Bouncing</td>
<td>Jumping up and down rapidly more than twice; Bouncing on bottom or knees rapidly more than twice</td>
</tr>
<tr>
<td>Spinning</td>
<td>Turning an object to one side more than three times</td>
</tr>
</tbody>
</table>

Table 3.3. Blake’s Stereotypic Behaviors and Definitions

**Task Engagement**

Task engagement was defined as on-task behaviors for that specific activity given to individual participant listed on Appendix D and E. On-task behaviors were determined by observing participants during Pre-PA, PA and Post-PA. On-task behaviors were coded on a direct-observation recording sheet (Appendix F). On-task behaviors were coded as a “+” if the participant was appropriately engaging in play items (during Pre-PA and Post-PA) and in physical activities (during PA), or attending to the investigator’s directions during a 6-s interval. More specifically, on-task behaviors were present when the participant exhibited (a) proper skills for the task (i.e., running during locomotor activity or watching pictures in a book during Pre-PA and Post-PA), (b) active visual attention to the investigator (e.g., about to initiate the task following to the direction) (i.e., reaching toward blocks when the investigator said “do you want to play with blocks?”), (c) appropriate use of various equipment, (d) appropriate transitions between activities.
following the investigator’s directions, (e) behaviors appropriate for the PA (LC or OM) although the behaviors were not matched with investigator’s direction (bouncing a ball when the investigator said “throw the ball” during object manipulation activity condition), and (f) when the participant was engaged in SBs while doing what he was supposed to do (e.g., vocalization while playing with play items).

On-task behaviors were not present when the participant engaged in (a) SBs with an item without attending or engaging correctly, (b) irrelevant activities not related to the condition (running away during OM without ball manipulation) (c) a tantrum, not engaging in activities or attending to items, and (d) no activities.

Both SBs and on-task behaviors during PA intervention were coded using a 6-s partial interval recording procedure (e.g., Groskreutz, Groskreutz, & Higbee, 2011; Wacker et al., 2011).

Heart Rate

The intensity of the participants’ physical activity was determined by a heart rate monitor. To ensure the LC and OM were fundamentally different, a portable fingertip pulse oximetry device (Nonin PalmSAT 2500; Nonin Medical, Inc, Plymouth, MN) was used to obtain estimated heart rates per minute (bpm). The bpm were obtained immediately before Pre-PA, immediately following PA, and immediately following Post-PA. The oximetry was selected because it has documented accuracy (Nonin Medical, 2004). Also it has been tested and approved by the US Army and US Air Force (e.g., Ross, Matteucci, Shepherd, Barker, & Orr, 2012). The oximetry required participants to put one of their fingers in a small clip. A sensor was attached to the clip where a sensor is
attached and in order to record heart rate the participants had to keep the finger motionless for three seconds.

Procedure

General

The procedures were held constant across all sessions and participants. The same equipment and activities were used in the same place and at a time of the day using the same recording equipment. The length of each session was also the same. The study was divided into three parts: 1) preference assessment, 2) functional analysis, and 3) physical activity intervention. The physical activity intervention used a three-component test sequence as used by Morrison et al. (2011). One three-component test sequence consisted of Pre-PA, PA, and Post-PA phases. Each phase was 5 minutes in duration. The same investigator conducted all intervention phases for all participants and the same behavior analyst conducted the preference assessment and functional analysis prior to the intervention.

All study procedures took place in the same location. Picture symbols were used throughout study since all the participants had been using them in their classrooms. The same pictorial symbols were used as in the classroom. Each participant was escorted to and from the study area by the investigator. The photos of study area can be found in Appendix G. The investigator did not intervene on any SBs exhibited by the participants during the entire test sequence unless severe self-injurious behaviors (e.g., Thomas’s head banging) would be occurred. No severe self-injurious behaviors were occurred
during the entire study period. All sessions were videotaped and behaviors scored at a later time.

*Specific*

The timeline for the entire study was about 12 weeks. Each participant had five preference assessment sessions, four sets of functional analysis sequences and a total of 16 sessions of physical activity intervention (8 LC and 8 OM). In order to examine further behavioral changes or durability of behavior changes, each participant sometimes had a follow-up phase of 5 minutes in duration. This 5-minute extended Post-PA was labeled as ‘Post 2 (Follow-up).’ The participants had this Follow-up phase once or twice in both LC and OM. Only one intervention session took place per day and the types of physical activities (LC or OM) were alternated each time.

All items as well as specific physical activity tasks were selected prior to the study through consultation with the school occupational therapists and classroom teachers. In addition, the investigator informally evaluated the participants’ gross motor competence to determine their ability levels.

All sessions were videotaped using Canon VIXIA HF S21 8.59 MP Camcorder. A preference assessment and functional analysis were conducted by a doctoral student who is a Board Certified Behavior Analyst (BCBA).

The following section describes in detail each of the three parts of the study.

1) *Preference Assessment*

Classroom teachers provided a list of preferred items for each participant. The assessment was used to identify appropriate play items for Pre-PA and Post-PA since
there was no guarantee that the participants would properly use the play items recommended by the classroom teachers. In addition, two moderately preferred items were identified for the ‘attention’ and ‘play’ conditions during functional analysis.

Multiple-stimulus without replacement—MSWO (e.g., DeLeon & Iwata, 1996) was used where the behavior analyst presented all potentially preferred items in an array and asked the participant to choose one. Six items were included in each assessment. During the assessment, each participant was seated in a chair at a table with the behavior analyst. The items were presented in a straight line on the table about 5 inches apart and the sequence of the item arrangement was randomized. Upon the behavior analyst’s verbal prompt, “Make a choice”, the participant was allowed to access one of the items. 30 seconds were given for the participant to play with the selected item. Immediately after the selection, the behavior analyst removed unselected items from the table to prevent multiple selections. Once an item was selected, it was not available to be selected again. If within 30-s the participant did not make a selection after the behavior analyst prompted, “Make a choice” a second verbal prompt “Make a choice” was provided. This was continued until all of the six items were selected or until the participant did not make any selection within 30-s from when he was told to “Make a choice” for the second time. The participant was verbally or physically redirected when needed. Scores for the play items were weighted based on the order in which they were selected. Based on a scoring system suggested by Ciccone, Graff, and Ahearn (2005), the item chosen first was scored six while the item chosen last was scored as one. If the participant did not make a selection upon the 2nd prompt, the session was terminated and the remaining items were...
recorded as “no choice.” Items not selected within a session received a score of zero for that session. Each of the participants went through 5 sessions. The coding sheet for the preference assessment can be found in Appendix H.

2) Functional Analysis

Functional analysis is an experimental procedure to determine the purposes or functions of a target behavior. It uses antecedents and consequences, observation, and measurement to determine the effects of presented conditions. The general process of functional analysis is often modeled after Iwata, Dorsey, et al. (1982/1994) who involved four conditions to evaluate the operant functions of self-injurious behaviors. During a functional analysis, each individual is repeatedly exposed to a series of brief conditions in which selected environmental events are manipulated systematically to the behavioral responses of the individual.

In this study, a functional analysis of SBs based on procedures described by Iwata, Dorsey, et al. (1982/1994) and Iwata, Wallace, et al. (2000) was conducted. The functional analysis included four conditions- attention, demand, play (control), and alone. The functional analysis procedures used in this study were similar to those described by Iwata, Dorsey, et al. (1982/1994) and Iwata, Wallace, et al. (2000) with some modifications. Because there was no observation room available and because the participants were preschool aged, the behavior analyst and the investigator stayed in the same room but no interaction or attention was delivered during the alone condition for the purpose of safety. In addition, a short version of the functional analysis (e.g., Northrup et al., 1991) was used because of the participants' ages. Each condition lasted for 5 minutes.
rather than for 10 minutes as in a traditional functional analysis (e.g., Iwata, Wallace et al., 2000). Descriptions of the three conditions and implementation of the assessment were directly retrieved from Iwata, Wallace, et al. (2000) with an additional description for the alone condition (Appendix I). The assessment area was confined with bookshelves to create boundaries.

One functional analysis session consisted of four conditions: attention, demand, play, and alone. Only one functional analysis session was carried out per day and the conditions were randomized. Over the two weeks, all participants experienced four functional analysis sessions. Using a coding sheet (Appendix J), SBs were measured using a momentary time sampling procedure with 10-s intervals (Gardnier et al., 2004) to determine the percentage of intervals in which each participant engaged in SBs during a 5-min observational period per condition. All SBs were coded using operational definitions described in Tables 3.1 to 3.3.

Based on the preference assessment, two moderately preferred play items were selected and used for the ‘attention’ and ‘play’ conditions. During the attention condition, the participant was allowed continuous access to moderately preferred items. The behavior analyst prompted the participant by saying, “(Name), please sit and play, I have work to do,” the participant was then given the items while the behavior analyst withdrew her attention. Attention was given contingent upon the SBs. Attention was provided for 3-5 seconds in the form of a verbal reprimand such as, “(Name), please stop doing that, you can hurt yourself. Play with your (name of play items).”
During the demand condition, slightly difficult tasks were continuously presented using a three-step prompting hierarchy (verbal, gestural, physical). Contingent on the target behavior, task materials were removed for 30-s. Verbal praise (e.g., “good job”) was delivered upon partial or complete performance of the task.

During the play condition, the same moderately preferred small activity items used in the attention condition were continuously accessible for the participant. The behavior analyst provided verbal attention every 30 seconds. No consequences for SBs were in effect.

During the alone condition, the participant was observed while alone in the designated area (surrounded by bookshelves) that contained no play items. Neither the behavior analyst nor the investigator provided any attention to the participant.

3) Physical Activity Intervention

Table 3.4 describes the length, location, participant-investigator interaction and heart rate monitoring in each phase of the physical activity intervention.

Two types of physical activities were used during PA phases—LC and OM activities. Each physical activity intervention session included three phases (Pre-PA, PA, and Post-PA) each of which lasted for 5-min (except when Follow-up was held). Only one session (or one test sequence) was conducted each day, and each phase within a session was presented immediately following the previous phase. Transition to the next phase typically took no more than 1 minute.
<table>
<thead>
<tr>
<th>Activity</th>
<th>Pre-PA</th>
<th>PA</th>
<th>Post-PA</th>
</tr>
</thead>
<tbody>
<tr>
<td>Activity</td>
<td>Free play with 4 preferred play items (a list of play items for each participant can be found in Appendix D)</td>
<td>LC or OM (a list of activities for LC and OM for each participant can be found in Appendix E)</td>
<td>Same as Pre-PA</td>
</tr>
<tr>
<td>Activity Area</td>
<td>Desk and chair area surrounded by bookshelves</td>
<td>Carpeted area right next to the Pre-PA and Post-PA areas. For running during LC condition, a hallway outside of the activity area was used.</td>
<td>Same as Pre-PA</td>
</tr>
<tr>
<td>Interaction with Investigator</td>
<td>Yes but no praise</td>
<td>Yes but no praise. Physical assistance provided if needed</td>
<td>Same as Pre-PA</td>
</tr>
<tr>
<td>Heart Rate Measure Length</td>
<td>Immediately before Pre-PA</td>
<td>Immediately after PA</td>
<td>Immediately after Post-PA</td>
</tr>
<tr>
<td>Length</td>
<td>5 min</td>
<td>5 min</td>
<td>5 min</td>
</tr>
</tbody>
</table>

Table 3.4. A Three-component Test Sequence.

Note: Pre-Pa=Pre-Physical Activity; PA=Physical Activity; Post-PA: Post-Physical Activity

Upon bringing each participant to the desk and chair area during Pre-PA and Post-PA, the investigator stated, “(Name), are you ready? Play with your toys.” At that time, the investigator started the video recording and went to the designated area for Pre-PA and Post-PA. A timer that provides the same sounds as used by the classroom teachers let participants know the time to transition to another phase (e.g., from Pre-PA to PA).

Immediately following PA, the participant would be told to go to the designated play area for Post-PA identical to Pre-PA.

Upon onset of PA (either LC or OM), the investigator directed the participant to the PA area and stated, “(Name), are you ready? Let’s do (name of activity).” Since the key
during PA was to make sure participants continuously engaged in relevant activities, the investigator on occasion had to physically direct and assist participants as needed. Picture symbols were used to help participants discriminate types of activities (OM or LC). The participants were allowed to have continuous access to PA items (described in Appendix E). The investigator verbally prompted participants to engage with the items (e.g., throwing a ball toward the participant saying “Catch!”). Additional prompts (e.g., physical) were provided if no engagement was observed or the participant engaged in SBs longer than 5-sec. Each participant always used the same PA items as described in Appendix E. Because of varying levels of motor development, not all participants could perform at the same level of motor proficiency when given the same items. Some deviation from the standard way to use the item was allowed if considered appropriate (see Appendix E).

Even though the pilot study showed there was no negative or positive effect of teacher praise or positive comments during PA on SBs, no teacher praise other than general verbal prompts (i.e., “Pick up the ball” or “Come over here”) were provided.

At the conclusion of Post-PA, the investigator stated, “All finished” and showed a symbol of classroom. The participant was told, "Name, it is time to go to the classroom." No free access to item engagement was allowed once a three-test sequence was completed to prevent potential satiation effects.

Heart rates were monitored immediately before Pre-PA, immediately following PA and at the completion of Post-PA. Only periodic checks were feasible since the participants refused to wear the device or check their heart rate for multiple times. Figure
3.1 illustrates the overall procedures for each phase.

![Figure 3.1. Illustration of Procedures. (Pre-PA= pre-physical activity phase; PA=physical activity phase; Post-PA=post-physical activity phase; Post-2= Post-2 Follow-up phase).](image)

**Procedural Reliability and Treatment Integrity**

Prior to data coding, a doctoral student underwent training to be a secondary observer for establishing reliability of the results. During the training sessions, the operational definitions for SBs and on-task behaviors were described. The investigator and the secondary observers achieved a minimum of 90% agreement during training. Exact inter-observer agreement was used with the formula (Cooper et al., 2007): 

\[
\text{Intervals agreed}/(\text{Intervals agreed} + \text{Intervals disagreed}) \times 100.
\]

The secondary observers independently recorded data during 40% of preference assessment, 50% of functional analysis sessions, and 38% of each of Pre-PA, PA, and Post-PA, and 100% of Post 2 (Follow-up) respectively.

Treatment integrity was also obtained using a treatment fidelity checklist (Appendix K) to evaluate potential treatment drift and to ensure that the intervention was carried out as planned (Cooper et al., 2007). Thirty eight percent of entire sessions (Pre-
PA, PA, and Post-PA) were assessed to determine whether or not the independent variables (LC and OM) were administered in a consistent manner. This included whether any praise was delivered, whether transition was immediate from one phase to the next phase, whether or not selected items were present, and whether prompts were used appropriately.

Social Validity

Wolf (1978) addressed the need for validating a practiced treatment. In this study social validity was determined through a written questionnaire to assess a) the extent to which the intervention will be accepted by teachers and viable if implemented in a real setting; b) the social appropriateness of the procedures; and c) satisfaction with intervention results. At the completion of the study, a questionnaire with a Likert-type scale (Appendix L) was given to the participants’ classroom teachers (n=3) along with one randomly selected a videotaped three-component test sequence. The questionnaire was aimed to ensure that the study were ethical, applied, and socially important (Cooper et al., 2007). Teachers also provided anecdotal feedback to the investigator on their opinions and perceptions of the intervention and their students’ SBs after the completion of the intervention.

Data Analysis

SBs and task engagement of each participant during functional analysis and physical activity intervention were coded and analyzed. Heart rate data were also presented relative to object manipulation and locomotor activities. Descriptive data included frequencies (heart rate), percentages and mean percentages. Data were also
analyzed using the percentage of non-overlapping data procedure. According to Kratochwill et al. (2010), the proportion of overlapping data points in two treatments can be used to establish experimental control. Scruggs, Mastroieri, and Castro (1987) suggest using 'percentage of non-overlapping data (PND)' in order to determine the effect size of a given treatment by calculating the percentage of data points in the treatment that exceeds the most extreme data point in another treatment or more. A visual inspection of graphed data was used to identify differences in responding.
Chapter 4: Results

The physical activity intervention results (object manipulation-OM and locomotor-LC) on stereotypic behaviors (SBs) of preschool children with ASDs are presented in this chapter. Seven major sections are included. The first and second sections present both the preference assessment and functional analysis results, respectively. The third section presents both the interobserver agreement and treatment fidelity results relative to the physical activity intervention data. The fourth section provides the physical activity intervention results for each participant. Finally, the last section describes results obtained from a social validity questionnaire.

Preference Assessment

From the preference assessment analysis, four items unique to each participant were chosen for both the Pre-PA and Post-PA phases. The preference assessment for Thomas (Participant 1) yielded cars, blocks, a puzzle, and magnets. Two moderately preferred items, blocks and a puzzle, were chosen for his functional analysis. The preference assessment for Aidan (Participant 2) yielded books, puzzles, blocks and magnets. A V-tech device was initially selected as a most preferred play item; however, it was eliminated because he did not exhibit any SBs when playing with it. Two moderately items, books and puzzles, were selected for his functional analysis. The preference
assessment for Blake (Participant 3) yielded a big toy truck, a color matching folder, puzzles, and magnets. The toy truck was eliminated because high SBs were evoked. During the 1st and 2nd sessions of the both OM and LC sessions, he showed highly excessive obsessive compulsive behaviors (i.e., spinning wheels) with the toy truck. Consequently upon the completion of both the 2nd OM and LC sessions, the truck was removed. Mega Blocks, chosen as a sixth preferred item was then substituted for the truck.

Interobserver agreement was established during the preference assessment based on the extent to which observers agreed with one another on the selection of items. The agreement between the investigator and independent observer was 100% for all item selections across the three participants.

**Functional Analysis**

A functional analysis was conducted to test the present and absence of SBs under four environmental conditions (Iwata et al., 1982/1994). Functional analysis results for the three participants are displayed in Figure 4.1.

As seen in Figure 4.1, Thomas (Participant 1) engaged in relatively stable SBs during the four conditions: alone ($M = 50\%$; range, $43\% - 53\%$), attention ($M = 45\%$; range, $33\% - 53\%$), demand ($M = 45\%$; range, $40\% - 50\%$), and play ($M = 49\%$, range, $30\% - 60\%$). No clear differentiation in responses among the conditions was observed. SBs were produced at high and consistent levels across all four conditions. Therefore, SBs were considered to be maintained by automatic reinforcement.
Figure 4.1. Functional Analysis Results for All Participants.
The results for Aidan (Participant 2) show similar patterns described for Thomas. Aidan engaged in a consistently high level of SBs during alone ($M = 73\%;$ range, $67\%–83\%$), attention ($M = 68\%;$ range, $57\%–83\%$), demand ($M = 62\%;$ range, $50\%–83\%$) and play ($M = 51\%;$ range, $33\%–70\%$). These results suggest that SBs also were maintained by automatic reinforcement.

The results for Blake (Participant 3) did not show a clear differentiation between the alone and attention conditions. High SB levels were exhibited during alone ($M = 53\%;$ range, $40\%–70\%$) and attention ($M = 48\%;$ range $37\%–70\%$). Low to moderate levels of SBs were exhibited during play ($M = 20\%;$ range, $7\%–50\%$) and demand ($M = 37\%;$ range, $23\%–50\%$) conditions. Despite the low SBs during the play condition (which provided Blake with a stimulus enriched environment), SBs were consistent in the absence of social contingencies (i.e., alone condition). These results may suggest that SBs were maintained by automatic reinforcement. However, elevated SBs during attention compared to play should be noted. These results suggest that SBs were also maintained by positive social reinforcement (e.g., adult attention). Therefore, the results suggest that SBs may have two functions (self-stimulation or automatic reinforcement, and attention).

For the functional analysis data, the same two observers scored the occurrence of SBs by watching videotaped data. The mean interobserver agreement (IOA) was 90\% (range, $83\%–95\%$) for Participant 1 (Thomas), 92\% (range, $83\%–100\%$) for Participant 2 (Aidan), and 90\% (range, $85\%–97\%$) for Participant 3 (Blake). The overall IOA across
the three participants was 91%. Since the mean IOA for SBs during all functional analysis conditions for each participant was above 85%, IOA was considered acceptable.

Interobserver Agreement and Treatment Fidelity for the Physical Activity Interventions

The interobserver agreement (IOA) percentages for SBs and on-task behaviors of the participants during three intervention phases (Pre-PA, PA, and Post-PA) in both OM and LC were calculated. Randomly selected sessions (38%) were identified from each of the three phases (Pre-PA, PA, and Post-PA) for each participant in both OM and LC. Thirty-eight percent of all sessions were considered to be appropriate according to Cooper et al. (2002).

Table 4.1 displays the mean IOA percentages for SBs and on-task behaviors across participants during OM and LC. The agreement in SBs between the investigator and independent observer was 95% for Thomas (range, 93-96), 96% for Aidan (range, 94-97), and 93% for Blake (range, 92-94) in OM and 95% for Thomas (range, 94-96), 95% for Aidan (range, 92-97), and 95% for Blake (range, 92-96) in LC, respectively. Mean agreement for SBs was 95% and 95% for on-task behaviors when results were aggregated across all participants’ responses. Acceptable IOA is considered to be 85% or higher.

Treatment fidelity for the physical activity intervention was established by using a checklist (Appendix K). It consisted of eight questions relative to 1) the interactions between the participants and the investigator, 2) transitions between phases (e.g., from Pre-PA to PA), 3) heart rate monitoring, and 4) the length of each phase. Treatment fidelity scores were obtained for each session (total = 152 phases including eight Follow-
Across all sessions and participants, the calculated mean percentage was 95%. The mean treatment fidelity percentages were 92%, 94%, and 98% for Thomas, Aidan, and Blake, respectively. Treatment fidelity results indicate that the physical activity intervention was carried out as planned (95% overall).

<table>
<thead>
<tr>
<th>Participant</th>
<th>Activity</th>
<th>Variables</th>
<th>Pre-PA</th>
<th>PA</th>
<th>Post-PA</th>
<th>Follow-up</th>
</tr>
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<tr>
<td>Thomas</td>
<td>OM</td>
<td>SBs</td>
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<td>95</td>
<td>96 %</td>
<td>93 %</td>
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<tr>
<td></td>
<td></td>
<td>On-task</td>
<td>94 %</td>
<td>94</td>
<td>94 %</td>
<td>95 %</td>
</tr>
<tr>
<td></td>
<td>LC</td>
<td>SBs</td>
<td>95 %</td>
<td>96</td>
<td>94 %</td>
<td>95 %</td>
</tr>
<tr>
<td></td>
<td></td>
<td>On-task</td>
<td>96 %</td>
<td>99</td>
<td>95 %</td>
<td>96 %</td>
</tr>
<tr>
<td></td>
<td>Both</td>
<td>SBs</td>
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<td>96</td>
<td>95 %</td>
<td>95 %</td>
</tr>
<tr>
<td></td>
<td></td>
<td>On-task</td>
<td>95 %</td>
<td>97</td>
<td>95 %</td>
<td>96 %</td>
</tr>
<tr>
<td>Aidan</td>
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<td>96</td>
<td>97 %</td>
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</tr>
<tr>
<td></td>
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<td>96</td>
<td>94 %</td>
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<tr>
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<td>92 %</td>
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<td></td>
<td>On-task</td>
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<tr>
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<td></td>
<td>On-task</td>
<td>94 %</td>
<td>96</td>
<td>93 %</td>
<td>93 %</td>
</tr>
<tr>
<td>Blake</td>
<td>OM</td>
<td>SBs</td>
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<td>94 %</td>
<td>93 %</td>
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<td>On-task</td>
<td>95 %</td>
<td>95</td>
<td>95 %</td>
<td>94 %</td>
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<tr>
<td></td>
<td>LC</td>
<td>SBs</td>
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<td>95</td>
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<td></td>
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<td>On-task</td>
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<td>SBs</td>
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<td>96 %</td>
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<tr>
<td></td>
<td></td>
<td>On-task</td>
<td>95 %</td>
<td>95</td>
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</tr>
</tbody>
</table>

Table 4.1. Mean Interobserver Agreement for Stereotypic Behaviors and On-task Behaviors for All Participants during Physical Activity Intervention (Object Manipulation-OM; Locomotor- LC).

Note: SBs=Stereotypic behaviors; On-task=On-task behaviors; Pre-PA=Pre-physical activity; PA=Physical activity; Post-PA=Post-physical activity; Follow-up=Post 2 (Follow-up).

Intervention Results for Each Participant

Detailed results for each participant from Pre-PA, PA, Post-PA, and Post 2 (Follow-up) during OM and LC are presented in Appendix M. This section includes the
results for SBs and on-task behaviors during the physical activity intervention (OM and LC). Each participant’s data are presented in seven subsections. First, overall SBs are presented in the first subsection. Post 2 (Follow-up) data across both OM and LC are presented in the second subsection. In the third subsection vocal, motor, and combined SBs are all presented. Direct comparisons of SB changes between Pre-PA and Post-PA are presented in the fourth subsection. Subsection five contains the direct comparison of on-task behavior changes between Pre-PA and Post-PA phases. Heart rate results comparing both OM and LC data are presented in the sixth subsection. The final subsection compares SBs and on-task data.

Thomas (Participant 1)

Stereotypic Behaviors

Figure 4.2 depicts SBs in Participant 1 resulting from PA (OM and LC). During PA, lower SBs were exhibited compared to Pre-PA and Post-PA phases. These lower levels in PA were observed in both OM and LC.

Data relate research questions 1a and 1b. They are: 1a) Will SBs change in the physical activity phase when compared to pre- and post-physical activity phase as a function of object manipulation or locomotor activities? and 1b) will SBs change in the post-physical activity phase compared to the pre-physical activity phase as a function of object manipulation or locomotor activities?

As to question1a, data show that consistently low SB levels during PA were generally produced. Only in two sessions in each of OM (1 & 6) and LC (2 & 6) SBs
were similar to Pre-PA. This indicates that Pre-PA SBs levels immediately decreased when Participant 1 experienced PA.

Figure 4.2. Interval Percentages of Stereotypic Behaviors by Thomas across Three Phases during Physical Activity Intervention. 

*Note: Pre=Pre-physical activity, PA=physical activity, Post=Post-physical activity.*
For question 1b, data show that differences in SB changes in Post-PA OM from Pre-PA OM compared to SB changes in Post-PA LC from Pre-PA LC. OM produced a similar or greater percent engagement in SBs. For example, in Post-PA the percent engagement in sessions 1, 2, and 3 (40%, 38%, & 46%, respectively) remained fairly stable compared to Pre-PA OM (44%, 42%, & 44%, respectively). Greater Post-PA engagement was found in sessions 2, 3, and 7 (54%, 74%, & 54%, respectively) when compared to Pre-PA (38%, 46%, & 42%, respectively). Only session 8 showed a decrease in SB engagement in Post-PA compared to Pre-PA (60% Pre-PA and 48% Post-PA).

Different patterns of SBs were exhibited in LC compared to OM. Results show a decreased percent engagement in Post-PA LC. The percentage of SBs decreased following LC activity in five of eight sessions. These patterns show a contrast in SBs compared to OM data which decreased in 1 session only. In Post-PA, percent engagement in SBs for sessions 2, 3, 6, 7 and 8 were 28%, 12%, 26%, 26% and 12%, respectively. These results were lower than the Pre-PA phase for those sessions (48%, 38%, 50%, 66%, & 58%). Three of the eight sessions (1, 3, & 5) showed similar SB engagement in Post-PA compared to Pre-PA.

Post 2 (Follow-up)

Research question 1c was: Will SBs change in the follow-up phase compared to the pre-physical activity phase as a function of object manipulation or locomotor activities? To answer this question, Follow-up data are presented in Figure 4.3. One Follow-up occurred in session six for both OM and LC.
Prior to OM (Pre-PA), Participant 1 (Thomas) engaged in SBs 38% of the time. After OM, he exhibited the same percentage. For Follow-up, he engaged in a greater percentage (60%) of SBs. Increased SBs were accounted for both vocal and motor SBs as well (see Appendix M).
The LC results show that the percent of SB engagement in Pre-PA (50%) decreased to 26% in Post-PA. During Follow-up, the percent engagement in SBs returned to the Pre-PA level (50%). It is interesting to note that the decreased percent engagement in motor SBs in Post-PA was maintained during Follow-up. This was not the case for vocal SBs. Again, the reader is referred to Appendix M for specific data.

*Mean Percentage of Vocal, Motor, and Combined Stereotypic Behaviors*

Research question 1d was: What are the effects of object manipulation and locomotor activities on vocal and motor SBs? Table 4.2 displays the average percent engagement in vocal and motor SBs as well as total SBs across all sessions in both OM and LC for Thomas.

<table>
<thead>
<tr>
<th>PA Type</th>
<th>SBs</th>
<th>Phases</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Pre-PA</td>
</tr>
<tr>
<td>OM</td>
<td>Vocal</td>
<td>22</td>
</tr>
<tr>
<td></td>
<td>Motor</td>
<td>28</td>
</tr>
<tr>
<td></td>
<td>Combined</td>
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</tr>
<tr>
<td>LC</td>
<td>Vocal</td>
<td>26</td>
</tr>
<tr>
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<td>Motor</td>
<td>30</td>
</tr>
<tr>
<td></td>
<td>Combined</td>
<td>49</td>
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</tbody>
</table>

Table 4.2. Thomas’s Mean Percent Engagement in Stereotypic Behaviors- SBs (vocal, motor, and combined) during Physical Activity Intervention Types (Object Manipulation-OM; Locomotor-LC) across Phases (Pre-Physical Activity, Pre-PA; Physical Activity, PA; and Post-Physical Activity, Post-PA).

For both OM and LC, the mean percent engagement in vocal, motor, and combined SBs during PA was lower than in either Pre-PA or Post-PA. In Post-PA OM the mean combined total SBs and motor SBs (49% & 38%, respectively) were higher.
than in Pre-PA (44% & 22%, respectively). The mean vocal SBs in Post-PA and Pre-PA were similar (21% & 22%, respectively). Therefore, it is assumed that increased motor SBs accounted for a higher percent engagement in total SBs in Post-PA when compared to Pre-PA.

Compared to OM, LC Post-PA the mean percent engagement was lower than Pre-PA (29% & 49%, respectively). Decreases in both vocal and motor SBs were found during LC Post-PA (13% & 19%, respectively) compared to Pre-PA (26% & 30%, respectively). The mean percent engagement in vocal SBs following LC activity (Post-PA) was lower than PA (13% & 17%, respectively).

Changes in Stereotypic Behaviors between Object Manipulation and Locomotor

Figure 4.4 illustrates the difference in SBs between OM and LC for Thomas in order to address research question 1: What are the effects of OM and LC on SBs of participants with ASDs?

OM Post-PA, SBs increased compared to Pre-PA levels. These results appear as data points below the x-axis. Unlike OM data, LC data appear above the x-axis for seven out of the eight sessions. Based on a visual analysis that is LC had a greater effect in reducing SBs than OM. The distances between the levels of OM and LC data points indicate differences across all sessions. The mean change in SBs was -4% in OM and 20% in LC.

According to Scruggs and Mastropieri (1994) the proportion of non-overlapping data points of one treatment should be greater than 70% to demonstrate its effect. Based
on Scruggs and Mastropieri (1994), calculated PND of LC for SBs was 63% which is close to but does not meet the 70% standard.

![Graph showing percentage change in stereotypic behaviors](image)

Figure 4.4. Percent Change Differences in Stereotypic Behaviors (from Pre-PA to Post-PA) by Thomas for Object Manipulation and Locomotor Activities. Values above the X-axis mean less Stereotypic Behaviors in Post-PA compared to Pre-PA.

*Physical Activity Heart Rates*

Heart rate monitoring was conducted to assess the intensities of both OM and LC activities (Figure 4.5) and address research question 2: What are the effects of object manipulation and locomotor activities on heart rates of participants with ASDs?
Results show that LC ($M=130\text{bpm}$, range 125-132) produced higher heart rates than OM ($M=102 \text{bpm}$, range 95-107). There were no overlapping data points across all sessions. While not shown in the Figure 4.5, the mean heart rates across all PA sessions for LC were 39 beats higher than Pre-PA, while for OM, the mean heart rates across all PA sessions were 10 beats higher than Pre-PA (See Appendix M).

![Figure 4.5. Participant 1 (Thomas) Heart Rate Results for Object Manipulation and Locomotor Activities.](image)

*Changes in On-task Behaviors between Object Manipulation and Locomotor*

Figure 4.6 illustrates the difference in on-task behaviors between OM and LC for
Thomas in order to address research question 3: What are the effects of object manipulation and locomotor activities on-task behavior in the post-physical activity phase compared to the pre-physical activity phase?

![Graph](image)

**Figure 4.6.** Percent Change Differences in On-task Behaviors (from Pre-PA to Post-PA) by Thomas for Object Manipulation and Locomotor Activities. Values above the X-axis mean greater on-task behaviors in Post-PA compared to Pre-PA.

OM Post-PA, on-task behaviors decreased compared to Pre-PA levels. These results appear as data points below the x-axis. Unlike OM data, LC data appear above the x-axis for seven out of the eight sessions. Based on a visual analysis, LC had a greater
effect in increasing on-task behaviors compared to OM. The distances between the levels of OM and LC data points indicate differences across all sessions. The mean increase in on-task behaviors was -11% in OM and 18% in LC. Based on Scruggs and Mastropieri (1994), calculated PND of LC for on-task behaviors was 25% which does not meet the 70% standard.

Relationship between Stereotypic Behaviors and On-task Behaviors

Figure 4.7 depicts percent engagement in SBs relative to on-task behaviors. The data relate to research question 4: What is the relationship between SBs and on-task behaviors observed in participants with ASDs?

Generally, when the percentage of SBs decreased during PA, the percentage of on-task behaviors increased. Similarly when the percentage of SBs increased during Post-PA, the percentage of engagement in on-task behaviors decreased. These patterns are observed for both OM and LC except for a few occasions (e.g., LC Post-PA session 2). When SBs and on-task behaviors were averaged, the results illustrate that OM produced greater SBs and reduced on-task behaviors (66% Pre-PA to 55% Post-PA), while LC produced fewer SBs and higher on-task behaviors (60% Pre-PA & 74% Post-PA).
Figure 4.7. Stereotypic and On-task Behavior Comparisons for Participant 1 (Thomas) for Pre-PA, PA, and Post-PA Phases.
Aidan (Participant 2)

*Stereotypic Behaviors*

Figure 4.8 depicts SBs of Participant 2 (Aidan) resulting from PA (OM and LC). The data relate to research questions 1a and ab. They are: 1) Will SBs change in the physical activity phase when compared to pre- and post-physical activity phase as a function of object manipulation or locomotor activities?; and 2) Will SBs change in the post-physical activity phase compared to the pre-physical activity as a function of object manipulation or locomotor activities?

As to research question 1a, the data reveal that in general consistently high SB levels during PA were produced. In particular, during PA OM, SBs were higher than Pre-PA in seven sessions (2, 3, 4, 5, 6, 7, & 8) and also higher than Post-PA in four sessions (1, 2, 5, & 6). Only one session showed lower SBs during PA than Pre-PA (94% & 82%, respectively). During LC activity (PA), SB levels found to be lower than PA OM across the 8 sessions. While not shown in the Figure 4.8, the percent of SBs during OM ranged from 62-94 and during LC from 34-82 (see Appendix M).

In order to address question 1b, Post-PA data were screened compared to Pre-PA. Data across the two phases (Pre-PA& Post-PA) revealed that Aidan differently responded to both types of physical activities. Increased SB levels during OM (PA) remained high in Post-PA. Slightly less or greater SBs were evident; however, the changes were minimal.
Figure 4.8. Interval Percentages of Stereotypic Behaviors by Aidan across Three Phases during Physical Activity Intervention.

Note: Pre=Pre-physical activity, PA=physical activity, Post=Post-physical activity.
For five of the eight sessions Post-PA data show increased SB levels compared to Pre-PA. For example, increases were observed in session 3 (76% Pre-PA & 96% Post-PA), 4 (58% Pre-PA & 74% Post-PA), 6 (54% Pre-PA & 60% Post-PA), 7 (64% Pre-PA & 74% Post-PA), and 8 (58% Pre-PA & 80% Post-PA). Only two sessions (1 & 5) were slight decrease in SBs from Pre-PA evident (session 1=90% Pre-PA & 84% Post-PA; session 5=60% Pre-PA & 46% Post-PA). Only session 4 resulted increased SBs following LC activity (62% Pre-PA and 70% Post-PA). Even with the increased SBs in session 4, motor SBs were found to decrease (see Appendix M).

Post 2 (Follow-up)

Follow-up data are presented in Figure 4.9. These data relate research question 1c: Will SBs change in the follow-up phase compared to the pre-physical activity phase as a function of object manipulation or locomotor activities?

One OM Follow-up occurred in session 6 and two LC Follow-ups occurred in sessions 6 & 7. Follow-ups revealed differences in SBs in both OM and LC. During Pre-PA OM, SBs were engaged in 54% of the time and during Post-PA OM, SBs increased to 60%. When Post-PA was extended to Follow-up, SB increased to 70%. Motor SBs decreased closed to zero for Post-PA and Follow-up (see Appendix M). For both LC Follow-ups (sessions 6 & 7) SBs were maintained at Post-PA levels (50% & 52% for session 6; 34% & 34% for session 7).
Figure 4.9. Changes in Stereotypic Behaviors by Aidan across Three Phases during Physical Activity Intervention.

Note: Pre=Pre-physical activity; Post=Post-physical activity; Post 2=Follow-up.
Mean Percentage of Vocal, Motor, and Combined Stereotypic Behaviors

Research question 1d was: What are the effects of object manipulation and locomotor activities on vocal and motor SBs? To answer this question, Table 4.3 displays the average percent engagement in vocal, motor, and combined total of SBs across all sessions in both OM and LC for Aidan.

<table>
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Table 4.3. Aidan’s Mean Percent Engagement in Stereotypic Behaviors- SBs (vocal, motor, and combined) during Physical Activity Intervention Types (Object Manipulation-OM; Locomotor-LC) across Phases (Pre-Physical Activity, Pre-PA; Physical Activity, PA; Post-Physical Activity, Post-PA).

For OM, the mean vocal and combined percentages were high during PA and Post-PA compared to Pre-PA levels. Vocal SBs in PA were higher than Pre-PA (72% & 60%, respectively) and similar to Post-PA (73%). Mean motor SBs remained at 25% for both PA and Pre-PA. Unlike vocal SBs, motor SBs decreased in OM Post-PA from Pre-PA levels (13% & 25%, respectively). Increased vocal SBs contributed to greater combined total of SBs for both PA and Post-PA.

For LC, the mean percent engagement in SBs during LC Post-PA was lower than Pre-PA and PA (68% & 52, respectively). Mean vocal SBs in Post-PA (46%) were lower
than both Pre-PA and PA (65% & 55%, respectively). Mean motor SBs in both PA and
Post-PA (5% & 8%, respectively) were lower than Pre-PA (20%). Fewer vocal and motor
SBs contributed to fewer combined totals in both PA and Post-PA.

**Changes in Stereotypic Behaviors between Object Manipulation and Locomotor**

Figure 4.10 illustrates the differences in SBs between OM and LC for Participant
2 in order to answer research question 1: What are the effects of OM and LC on SBs of
participants with ASDs?

![Figure 4.10. Percent Change Differences in Stereotypic Behaviors (from Pre-
PA to Post-PA) by Aidan for Object Manipulation and Locomotor Activities. Values
above the X-axis mean less Stereotypic Behaviors in Post-PA compared to Pre-PA.]

The distances between the OM and LC indicate differences across the majority of
sessions. When compared to OM Post-PA, SBs increased from Pre-PA levels. Only two of the eight data points are located above the x-axis. Unlike OM data, LC data appear above the x-axis. Seven of the eight data points appear above the x-axis, indicating that LC produced fewer SBs. Therefore, based on a visual analysis, LC seemed to have a greater effect in reducing SB as compared to OM.

The distances between the levels of OM and LC data points indicate differences across all sessions. The mean change in SBs was -6% in OM and 19% in LC. The proportion of overlapping data points was calculated. PND (Scruggs & Mastropieri, 1994) of LC for SBs was calculated at 50% which does not meet the 70% standard for an effective intervention. Therefore, the second extreme data point in OM was selected for the PND analysis. When the second extreme data point in OM was selected, 75% of PND was achieved.

*Physical Activity Heart Rates*

Heart rate monitoring assessed the intensities of both OM and LC activities (Figure 4.11). These data address research question 2: What are the effects of object manipulation and locomotor activities on heart rates of participants with ASDs?

The results indicate that LC activity ($M=128$ bpm, range 122-137) produced higher heart rate than OM activity ($M=102$ bpm, range 96-110). There were no overlapping data points between OM and LC across all sessions. While not shown in Figure 4.11, mean LC activity heart rates across all sessions were 42 beats higher than Pre-PA, while the mean OM activity heart rates were 12 beats higher compared to Pre-PA (see Appendix M).
Changes in On-task Behaviors between Object Manipulation and Locomotor Activities

Figure 4.12 illustrates the difference in on-task behaviors between OM and LC for Participant 2 in order to address research question 3: What are the effects of object manipulation and locomotor activities on on-task behavior in the post-physical activity phase compared to the pre-physical activity phase?

As seen in Figure 4.12, variability was present in on-task behavior data for both OM and LC. There are data points below the x-axis in 2 sessions for OM and in 4 sessions for LC, thus indicating that Post-PA on-task behaviors decreased compared to Pre-PA levels. The three of the four LC sessions show data points below the x-axis, however, they indicate less than a 10% decrease in on-task behaviors. Based on a visual analysis, it is difficult to determine whether OM or LC had a greater effect in increasing
on-task behaviors. The distances between OM and LC data points indicate no differences across all sessions. The mean change in on-task behaviors was 5% in OM and 1% in LC. The calculated PND of LC for on-task behaviors was zero which indicates a lack of experimental control for on-task behaviors in Participant 2.

Relationship between Stereotypic Behaviors and On-task Behaviors

Figure 4.13 depicts the percent engagement in SBs relative to on-task behaviors. The data relates to research question 4: What is the relationship between SBs and on-task behaviors observed in participants with ASDs?
Figure 4.13. Stereotypic and On-task Behavior Comparisons for Participant 2 (Aidan) for Pre-PA, PA, and Post-PA Phases.
Generally, the percentage of on-task behaviors is relatively high across all sessions in both OM and LC. An inverse relation between SBs and on-task are found in a majority of the sessions. While not shown in Figure 4.13, when SBs and on-task behaviors were averaged, the results indicate high on-task behaviors across all three phases (Pre-PA, PA, & Post-PA) regardless of increases or decreases in SBs (see Appendix M).

Blake (Participant 3)

Stereotypic Behaviors

Figure 4.14 depicts SBs of Participant 3 (Blake) resulting from PA OM and LC. These data relates to research questions 1a and 1b. They were 1) Will SBs change in the physical activity phase when compared to pre- and post-physical activity phase as a function of object manipulation or locomotor activities?; and 2) Will SBs change in the post-physical activity phase compared to the pre-physical activity as a function of object manipulation or locomotor activities?

For question 1a, PA data in both OM and LC were examined. During PA, high SBs were observed in both OM and LC. In particular, during OM activity (PA), SBs were higher than in Pre-PA in seven sessions (1, 3, 4, 5, 6, 7, & 8) as well as higher than in five Post-PA sessions (1, 5, 6, 7 & 8). During LC activity (PA), SBs were higher than Pre-PA in four sessions (1, 3, 7 & 8) and in six Post-PA sessions (1, 2, 5, 6, 7, & 8). While not shown in the Figure 4.14, the percent of SBs during OM and LC ranged from 36%-88% and 18%-78%, respectively (see Appendix M).
Figure 4.14. Interval Percentages of Stereotypic Behaviors by Blake across Three Phases during Physical Activity Intervention.

Note: Pre=Pre-physical activity, PA=physical activity, Post=Post-physical activity
In order to address question 1b, Post-PA data were screened compared to Pre-PA for both OM and LC. First, OM Post-PA data indicate that SBs were higher than Pre-PA levels in seven of the eight sessions. For example, in session 3, the percent engagement of SBs increased from 28% (Pre-PA) to 72% (Post-PA). Only session 7 produced decreased SBs in OM Post-PA (48% Pre-PA, 16% Post-PA).

When LC data were examined, decreases in SBs in Post-PA for five of the eight sessions were found. Even though LC SBs in sessions 1 and 2 show little or no changes, decreased SBs in Post-PA were observed in five sessions (3, 4, 5, 6, & 8). For example, in session 5 the percentage of SB engagement was 86% in Pre-PA and decreased to 24% in Post-PA. Only session 7 showed increased SBs following LC.

Post 2 (Follow-up)

Follow-up data are presented in Figure 4.15 and relate to question 1c: Will SBs change in the follow-up phase compared to the pre-physical activity phase as a function of object manipulation or locomotor activities?

One Follow-up occurred in session 5 for both OM and LC. Prior to OM, SBs were observed in 36% of the time. For OM Post-PA, SBs increased to 60%. The percentage of SBs in Post-PA and Follow-up was attributed to an increase in motor SBs (see Appendix M). Motor SBs increased from Pre-PA to Post-PA (4% to 42%). Motor SBs decreased to 30% in Follow-up.

LC Follow-up data show that SBs decreased in Post-PA (86% Pre-PA, 24% Post-PA) and remained low in Follow-up (36%). Despite a slight increase from Post-PA, SBs in Follow-up were lower than Pre-PA levels. Both Post-PA vocal and motor SBs
decreased from Pre-PA levels and slightly increased in Follow-up (see Appendix M).

Figure 4.15. Changes in Stereotypic Behaviors by Blake across Three Phases during Physical Activity Intervention.

Note: Pre=Pre-physical activity; Post=Post-physical activity; Post 2=Follow-up.
Mean Percentage of Vocal, Motor, and Combined Stereotypic Behaviors

Research question 1d was: What are the effects of object manipulation and locomotor activities on vocal and motor SBs? In order to answer this question, Table 4.4 displays the average percent engagement in vocal, motor, and combined SBs across all sessions in both OM and LC for Blake.

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Table 4.4. Blake’s Mean Percent Engagement in Stereotypic Behaviors- SBs(vocal, motor, and combined) during Physical Activity Intervention Types (Object Manipulation-OMl Locomotor-LC) across Phases (Pre-Physical Activity, Pre-PA; Physical Activity, PA; and Post-Physical Activity, Post-PA).

For both OM and LC, the mean percent engagement in the combined totals of SBs in PA was higher than in Pre-PA and Post-PA levels. It should be noted that for OM, increased combined total for SBs (41% Pre-PA, 59% Post-PA) during OM PA were attributed to high motor SBs (23% Pre-PA, 45% Post-PA). Slightly increased combined total of SBs during LC PA was accounted for by increased vocal SBs. Following OM, mean vocal, motor and combined total SBs increased compared to Pre-PA levels. In particular mean motor SBs increased in Post-PA compared to Pre-PA (44% to 23%).
Therefore, a higher mean percentage of total SBs following OM than Pre-PA was attributed to increased motor SBs.

For LC, the mean percent engagement in SBs during LC Post-PA was lower than Pre-PA levels (29% & 46%, respectively). Decreases in both vocal and motor SBs were found following LC Post-PA (16% & 15%, respectively) compared to Pre-PA levels (31% & 27%, respectively).

*Changes in Stereotypic Behaviors between Object Manipulation and Locomotor*

Figure 4.16 illustrates the differences in SBs between OM and LC for Participant 3. It addresses research question 1: What are the effects of OM and LC on SBs of participants with ASDs?

When a visual analysis was conducted on the distances between OM and LC data points there were differences across a majority of sessions. The mean change in SBs was -6% in OM and 19% in LC. In OM Post-PA, SBs increased compared to Pre-PA levels. These results appear as data points below the x-axis. Only one OM data point appears above the x-axis. In LC, six of eight data points fall below the x-axis indicating positive results. The visual analysis shows that LC rather than OM activity may have had a greater effect in reducing SBs.

The distances between the levels of OM and LC data points indicate differences across all sessions. The mean change in SBs was -14% in OM and 16% in LC. The proportion of overlapping data points was again calculated. The calculated PND (Scruggs & Mastropiere, 1994) of LC for SBs was 13% which does not meet the 70% standard for
an effective intervention. Since only one data point in OM was an outlier, the second extreme data point was used for the PND analysis. The results show 88% of PND.

Physical Activity Heart Rates

Heart rate monitoring assessed the intensities of both OM and LC activities (Figure 4.17). These data address research question 2: What are the effects of object manipulation and locomotor activities on heart rates of participants with ASDs?

Results show that LC activity produced higher heart rates (M=39 bpm, range 125-180) than OM activity (M=103 bpm, range 100-107). There were no overlapping data
points for OM and LC across all sessions. While not shown in Figure 4.17, the mean heart rates across all LC sessions were 52 beats higher than in Pre-PA, while in OM, the mean heart rates across all sessions were 11 beats higher compared to Pre-PA (see Appendix M).

Figure 4.17. Participant 3 (Blake) Heart Rate Results for Object Manipulation and Locomotor Activities.

Changes in On-task Behaviors between Object Manipulation and Locomotor

Figure 4.18 illustrates the difference in on-task behaviors between OM and LC for Participant 2 and address research question 3: What are the effects of object manipulation
and locomotor activities on on-task behavior in the post-physical activity phase compared to the pre-physical activity phase?

As seen in Figure 4.18, OM Post-PA, on-task behaviors decreased compared to Pre-PA levels. These results appear as data points below the x-axis. Unlike OM data, LC data appear above the x-axis for seven out of the eight sessions. Based on a visual analysis, that is LC had a greater effect in increasing on-task behaviors than OM. The distances between the levels of OM and LC data points indicate differences across all

![Figure 4.18. Percent Change Differences in On-task Behaviors (from Pre-PA to Post-PA) by Blake for Object Manipulation and Locomotor Activities. Values above the X-axis mean greater on-task behaviors in Post-PA compared to Pre-PA.](image-url)
sessions. The mean change in on-task behaviors was -27% in OM and 14% in LC.

The calculated PND (Scruggs & Mastropieri, 1994), of LC for on-task behaviors was zero indicating no experimental control for on-task behaviors. However, when the second most extreme data point in OM was selected for the calculation, the PND was 88% indicating the effectiveness of LC in increasing on-task behaviors in Participant 3.

Relationship between Stereotypic Behaviors and On-task Behaviors

Figure 4.19 depicts the percent engagement in SBs relative to on-task behaviors. The data address research question 4: What is the relationship between SBs and on-task behaviors observed in participants with ASDs?

Generally, when the percentage of SBs decreased, the percentage of on-task behaviors increased. Similarly when the percentage of SBs increased, the percentage of on-task behaviors decreased. These patterns are observed in both OM and LC except for a few occasions (e.g., data in LC session 1 show increased SBs and high on-task behaviors).

While not shown in Figure 4.19, when SBs and on-task behaviors were averaged, the results indicate OM activity increased SBs (41% Pre-PA, 56% Post-PA) and reduced on-task behaviors (62% for Pre-PA, 35% Post-PA). Following LC activity, SBs decreased (46% Pre-PA, 29% Post-PA) and on-task behavior increased (54% Pre-PA, 68% Post-PA). Specific data can be found in Appendix M.
Figure 4.19. Stereotypic and On-task Behavior Comparisons for Participant 3 (Blake) for Pre-PA, PA, and Post-PA Phases.
Social Validity Results

The physical activity intervention relative to LC activity was selected for the social validity questionnaire because the results suggested that LC activity had a greater effect in reducing SBs than OM activity. Following the physical activity intervention, the participants’ classroom teachers (n=3) were asked to complete a social validity questionnaire (Appendix L). All three teachers completed and returned the questionnaire.

Five response categories used were ‘Strongly Disagree,’ ‘Disagree,’ ‘Neutral,’ ‘Agree,’ and ‘Strongly Agree.’ Questionnaire results revealed that overall the responses indicated favorable attitudes of teachers toward the LC activity component. All teachers believed that LC activity reduced SBs and produced more task engagement and all strongly agreed that the LC activity provided participants with enjoyable experiences. Based on the results of the study, they supported the physical activity intervention. Their responses indicated that LC activities are an appropriate and effective way to deal with SBs. In addition, all teachers did not believe that more SBs were observed following LC activity (Post-PA). Similarly all teachers did not believe there was any potential discomfort of their students to physical activity.

Overall the teachers agreed or strongly agreed to six positive statements regarding the intervention. All respondents strongly disagreed with both statements that indicated potential negative influences of the intervention. In summary, results suggested that the LC activity component was considered to be effective in reducing SBs.
Summary of Results

The purpose of this study was to identify the effects of two types of physical activities (OM and LC) in reducing SBs. Changes in vocal and motor as well as total SBs were examined. In addition, heart rates were measured to determine if intensity differences between OM and LC activities existed. Finally, the relationship between SBs and on-task behaviors was examined.

A comparison between Post-PA and Pre-PA SBs revealed that compared to OM, LC produced a greater effect in reducing SBs. For LC, all participants engaged in fewer SBs during LC Post-PA compared to Pre-PA. For OM Post-PA, participants engaged in more SBs compared to Pre-PA. Follow-up (Post 2) indicated that increased SBs in Post-PA remained high in Follow-up for all participants. Similarly, decreased SBs for LC (Post-PA) remained relatively low in Follow-up for two of three participants. Increased SBs for OM Post-PA were accounted for by increased motor SBs. For LC Post-PA, decreases in SBs were attributed to both vocal and motor SBs. During OM PA, high SBs were found for two of three participants. During LC PA, only one participant exhibited slightly higher SBs. Heart rate results suggest that all participants engaged in more vigorous physical activity during LC compared to OM.

Overall, participants engaged in more SBs during OM PA and Post-PA OM. When compared to Pre-PA, increased SBs during Post-PA were accompanied by low on-task behaviors. Compared to OM, LC produced fewer SBs both during (PA) and after (Post-PA) activity. Results from visual analyses indicate that when decreased SBs for LC Post-PA were found, greater on-task behaviors were concurrently observed. Social
validity results suggested that teachers believed that LC activity reduced SBs and promoted on-task behaviors, was socially appropriate, and able to be delivered in an educational setting.
Chapter 5: Discussion

This chapter is composed of four sections. The first section provides a discussion of each of the sub and main research questions. The second section addresses the study’s implications for practitioners as well as future programming, while the third section addresses future research. The final section provides a concluding summary of the study.

Research Questions

1. What are the effects of object manipulation and locomotor activities on SBs of participants with ASDs?

   Study results show decreases and increases in SBs following LC and OM activities, respectively. When visual analyses were conducted for OM and LC data, more LC data points above the x-axis were found indicating decreased SBs for LC compared to those for OM. But when PND was calculated for LC, only no intervention effects were found (range, 13-50). However, when the second most extreme data point was calculated, the results indicate a moderate to strong effect (range, 63-88). The weak effect size for LC was found to be different from the visual analysis. It may have been due to the variability in SB changes. SBs decreased after LC compared to Pre-PA LC and increased after OM compared to Pre-PA OM, the amount of such changes varied across sessions. This can be explained by a greater effect size when a second most extreme data point in OM was selected for the LC PND calculation. The results may indicate the use of other
procedures that can rule out data variability. Examples include the percentage of data points exceeding the median of the baseline phase (PEM; Ma, 2006) and standard mean difference (SMD; Busk & Serlin, 1992). It should be noted that none of the approaches can accurately interpret data variability. Visual analyses seem to better capture trend and variability than other aforementioned non-regression approaches. Olive and Franco (2007) recommend combining the use of the non-regression approaches along with visual analysis in order to ensure a comprehensive understanding and interpretation of the intervention effect.

One threat to the internal validity of findings in this study was the variability of SBs in Pre-PA across sessions. However, variability is inherent in human behavior and especially for those with autism who exhibit SB. This inherent variability is observed in natural environments (baseline observations) and may simply be a function of SBs. The variability of SBs was why Morrison et al. (2011) used the three-component test sequence to examine behavior changes between pre- and post-treatment, session by session. Nonetheless, one potential reason for the variability of SBs in Pre-PA across sessions could have been the use of both vocal and motor SBs. This may have accounted for the variability in SB responses to OM and LC. If either vocal or motor SBs were measured (not both), perhaps more stable Pre-PA data in SBs may have been found.

The following four questions under research question 1 were generated to provide more detailed answers regarding the changes in SBs as a function of OM and LC.

1a) Will SBs change in the physical activity phase when compared to pre- and post-physical activity phase as a function of object manipulation or locomotor activities?
Answering this question was considered important because what happened during physical activity may contribute to explain changes in SBs following a particular physical activity type. Limited research has been conducted related to SBs and physical activity. Only one study (Morrison et al., 2011) observed SBs during two conditions (exercise or leisure). Although intensities were not measured, the intensity of the leisure intervention which included books, blocks, and small toys was considered less intense than the exercise intervention (e.g., therapy ball, stationary cycle, scooter board). Both exercise and leisure conditions suppressed the SBs of all participants with ASDs during activities. Morrison and colleagues argued that decreased SBs resulted from abolishing effects such that the continuous access to preferred items provided sensory experiences matched to consequences of SBs. Unfortunately, they did not provide explanations regarding potential reasons for different post-intervention effects in relation to the behavioral patterns found during engagement. Therefore, it was not clear why fewer SBs were observed following exercise compared to leisure despite that fewer SBs were observed during both.

The current study showed consistent results with the Morrison et al. (2011) study. Thomas (Participant 1) exhibited overall fewer SBs during PA compared to Pre-PA and Post-PA in both OM and LC. In PA LC, all participants engaged in fewer SBs than in Pre-PA LC. However, somewhat mix results were also found when compared the Morrison, et al. (2011) study. Unlike their study, the current study results show more SBs in PA OM than in both Pre-PA OM and Post-PA OM in two of the three participants. Average SB levels during OM for all participants were always higher than during LC.
When vocal and motor SBs were analyzed separately for PA OM, Aidan (Participant 2) and Blake (Participant 3) showed more vocal SBs than Pre-PA OM. For Blake, higher motor SB levels were observed in PA OM but more vocal SBs in PA LC. These inconsistent results can be explained in several ways.

First, competing stimuli were taken into consideration. PA results indicate that LC motor tasks might have produced more physical incompatibility with OM motor SBs. Fewer SBs in PA OM were observed only in Participant 1 (Thomas). Suppressing SBs during physical activity can be achieved by providing tasks that can evoke competing responses. The competing responses should be physically incompatible with target behaviors. For example, providing a ball-playing task may suppress hand flapping. According to Rapp (2007), automatic reinforcement can be temporarily replaced by an alternative sensory reinforcement through stimulus competition. OM activity might have required Thomas to emit movement physically incompatible with his motor SBs. While Thomas was manipulating the OM items, his motor SBs might have been temporarily suspended. It should be noted that majority of Thomas’ motor SBs involved hand movements. For Aidan, however, major motor SBs did not involve hand movements and he mostly engaged in a high number of vocal SBs. This provides a potential reason why Aidan’s SBs during OM were not effectively suppressed.

For Blake, unlike the two other participants, the various balls used during OM were stimulating to him. Playing with the balls seemed to act as “turning on the switch” to his sensory system. For instance, whenever holding a ball, he licked and rubbed it against his body. This strong obsessive-compulsive behavior was difficult to redirect.
This also occurred when he was given a toy truck. Consequently his toy truck was eliminated from Pre-PA and Post-PA. According to Ahearn, Clark, Gardenier, Chung, and Dube (2003), temporarily providing preferred items that are not otherwise accessible or available could increase SBs due to motivational operations (e.g., Rapp, 2004, 2005). Therefore, for Blake, temporarily providing a preferred item such as a ball increased his SBs because that item is not otherwise available during the school day. Practitioners often use equipment with various colors, shapes, and textures. Blake’s during OM suggests that teachers and researchers who provide physical activity to children with ASDs should carefully select the activity items considering potential stimulating effects. Some physical activity items could stimulate sensory systems more and aggravate SBs.

The results of this study indicate that an abolishing operation can be identified only when decreased SBs are observed following physical activities. This means that decreased SBs during physical activities may not be a true indication of abolishment from antecedent physical activity. Results of Morrison et al. (2011) also indicated low problem behaviors during both exercise and leisure engagement. But post-exercise and post-leisure did not. The levels of both verbal and motor SBs following physical activities should be considered as well as physical incompatibility. Competing responses can temporarily suppress SBs in PA but can fail to decrease them in Post-PA. This may indicate that competing responses do not always provide the same stimuli generated by the SB.

With the exception of Aidan, the other two participants required physical assistance on occasion due to poor movement skills and balance. Even though physical
activity sessions were carefully designed to meet motor competency levels of individual participants, occasional physical assistance was unavoidable especially when they requested help (e.g., voluntarily holding the investigator’s hand). This might have caused a confounding effect when the participants emitted motor SBs. In addition, OM rather than LC tasks may have provided more challenging experiences considering their limited OM competence. This could have increased their SBs even though functional analysis results did not indicate that SBs were maintained by an escaping contingency (demand condition). In addition, through consultation with their teachers as well as through observations, motor tasks and items appropriate for each participant’s ability and preference were used. Formal preference assessments on the motor items were not conducted. Morrison et al. (2011), however, conducted preference assessments to identify and provide matched sensory stimuli using both exercise and leisure items.

1b) Will SBs change in the post-physical activity phase compared to the pre-physical activity phase as a function of object manipulation or locomotor activities?

Previous studies on antecedent physical activity interventions reported fewer SBs following vigorous physical activity compared to less vigorous physical activity (Celiberti et al., 1997; Kern, Koegel, & Dunlap, 1984; Kern, Koegel, Dyer, et al., 1982; Levinson & Reid, 1993; Waters & Watters, 1980). The studies used similar activities but two different intensity levels (e.g., jogging versus walking). Kern, Koegel and Dunlap (1984) used two different activities (jogging and ball-playing), assuming the two would produce different intensity levels. Results were similar to previous studies in that ball-
playing had little or no effect in reducing SBs but jogging did decrease SBs (Kern, Koegel & Dunlap, 1984).

All participants in the current study engaged in fewer SBs following LC. In OM, however, increased SBs were observed. Decreased SBs following LC were consistent with previous research on the effect of vigorous PA (e.g., Celiberti et al., 1997; Koegel, & Dunlap, 1984; Kern, Koegel, Dyer, et al., 1982; Kern, Levinson & Reid, 1993; Morrison et al., 2011; Reid et al., 1988; Waters & Watters, 1980). However, the current study added new evidence. Plausible explanations can be offered regarding SBs following physical activities.

First, the notion of matched or unmatched stimuli might explain the current results. Levinson and Reid (1993) as well as Berkson (1983) suggest that automatically reinforced SBs can be reduced when an alternative activity is provided, but the activity should produce the same or similar sensory consequences of the SBs. Levinson and Reid (1993) stated that jogging might provide matched sensory input motor SBs. They argued that jogging (a whole body movement) was effective for reducing SBs because of the resemblance between jogging and the motor SBs of their participants. According to a LeBlanc et al., (2000), reduction or extinction of SBs is achieved through either stimulus competition (engagement in incompatible behavior with the SB) or stimulus substitution (generation of similar or identical stimulation to the SB). Therefore, the physical activities used in the current study may have provided participants with either competing stimuli or stimuli that could have been substituted for their sensory needs. From this perspective, OM might have acted as a competing stimulus. This is why motor SBs
appeared to be temporarily reduced during OM. However, as mentioned earlier, those SBs would eventually return and may even increase (e.g., Forehand & Baumeister, 1973; Rapp et al., 2004). This was observed in OM for Thomas and Aidan, since their decreased SBs in PA OM increased in Post-PA OM. For Blake, OM items stimulated his sensory system in PA and greatly increased his SBs. His SBs continuously increased in Post-PA. In contrast to OM, LC seemed to provide participants with substitutable stimuli. Therefore, consistent with Morrison et al. (2011), decreased LC activities functioned as an abolishing operation to decrease SBs.

Second, PA in this study might have created enriched environments (e.g., Vollmer, Marcus, & LeBlanc, 1994; LeBlanc, 1994) where LC activities compared to OM activities had more coincidental stimuli that were matched to participants’ SBs. As Levinson and Reid (1993) have suggested, LC activities comprised of whole body movements may have provided substitutable stimuli for their sensory needs because of the movement similarities with SBs. Watters and Watters (1980) on other hand stated that SBs may or may not have been reduced because of movement similarities.

In sum, the current study indicates that reduction in SBs following physical activity might be the result of either stimulus competition or stimulus substitution or both. Due to physical incompatibility, SBs were temporarily decreased when competing stimuli were provided. But stimulations generated by competing stimuli do not always serve as a substitute for the stimulations generated by SBs. When SBs increased in Post-PA OM, it was an indication that the stimuli provided by OM activities only suppressed SBs through stimulus competition but failed to become a substitutable stimulus. For LC activities SBs
always decreased in Post-PA and those activities served as a stimulus substitution, whether it provided physical incompatibility or compatibility. Therefore, LC activities provided substitutable stimuli as well as a potential abolishing operation effect.

1c) Will SBs change in the follow-up phase compared to the pre-physical activity phase as a function of object manipulation or locomotor activities?

Some researchers have conducted extended observations following physical activity to address the durability of behavior changes (e.g., Celiberti et al., 1997; Levinson & Reid, 1993; Kern, Koegel, Dyer, et al., 1982). In the current study Post 2 (Follow-up) results 5 minutes following Post-PA were conducted on selected sessions for all participants. These follow-up results indicate similar or increased SB levels in both OM and LC compared to Post-PA. The SB increases in LC follow-up were minimal (still lower than Pre-PA). Although SBs remained low, these temporal effects indicate that SBs might gradually return to Pre-PA levels. These results were consistent with previous studies.

Levinson and Reid (1993) reported that after 90-min of jogging participants’ SBs returned to the same or higher pre-activity levels. These findings were consistent with other studies (e.g., Kern et al., 1992; Celiberti et al., 1997).

The current study conducted an extended follow-up in order to identify if the results found in Post-PA could be extended for a modest 5-minute period. Decreased SBs have been observed immediately after vigorous physical activity; however, behaviors returned to original levels (Levinson & Reid, 1993). The durability of physical activity effects on SBs is unclear. Celiberti et al. (1997) found that SBs increased after 10-min of
physical activity. Kern, Koegel, Dyer, et al. (1982) on the other hand found that SBs remained low for as long as 15 minutes following activity. For the current study, positive LC activity effects were relatively well maintained in follow-up. However, the follow-ups were not made for every session and were only 5 minutes Post-PA phases. The limited number of follow-ups was unavoidable in order minimize disruptions to regular school schedules. For the current study, participants usually had lunch, outdoor recess time, and/or watching videotapes following data collection sessions. In fact, how quickly SBs would resume to their original levels can be related to a number of factors. Prupas and Reid (2001) reported that SBs were more effectively decreased when structured classroom activities followed exercise. These results indicate that it is important to consider what children do following PA. Thus, if one is interested in measuring the durability of physical activity on SBs, behaviors should be measured at specific times of the day when students participate in the same activities. The current study took place at a consistent time in the day throughout the entire study period and this effort might have contributed to minimizing extraneous variables due to other activities experienced by the participants prior to the intervention. However, this study did not identify specific classroom activities individual participants experienced prior to the physical activity intervention. Various classroom activities may bring synergic effects when experienced immediately before or after LC activity.

1d) What are the effects of object manipulation and locomotor activities on vocal and motor SBs?
The results of the current study show different changes between vocal and motor SBs during OM and LC suggesting that there may be two mechanisms in operation. First, this study showed that vocal SBs could be coincident with other physical tasks. Aidan’s vocal SBs were still exhibited even when he actively engaged in physical activity (e.g., vocalization when throwing a ball). Furthermore, vocal SBs sometimes seemed to express excitement or anger. While natural laughing or screaming was not coded a SB, vocal SBs seemed to be influenced by emotional states. For instance, Blake’s high SB levels during OM and LC were attributed to his excitement. When Blake was excited, he engaged in vocal SBs. In general he was highly on-task during 96% during as opposed to 70% during OM activity indicating that he probably enjoyed LC more than OM. Consequently, his vocal SBs during LC were more apparent than during OM. In addition, he tended to ask for physical assistance during LC (e.g., holding the investigator’s hands while jumping on the trampoline). It should be noted that his SBs were potentially maintained by both automatic and social reinforcement. Considering the fact that he typically was not allowed to touch anyone else in the classroom, physical contact freely available in LC was considered a source for his excitement. Thus, this physical contact as a social reinforcement might have evoked his SBs. This potentially different response of vocal SBs from motor SBs to physical activity could be better identified using an auditory stimulus during physical activity (e.g., use of music). Use of an auditory stimulus component may provide evidence of how vocal SBs react to physical activity with existence and absence of auditory stimuli. Even though several studies have reported the effects of providing auditory stimuli on SBs (Ahearn,
Clark, DeBar, & Florentino, 2005; Morrison et al., 2011; Rapp 2007), to this investigator’s knowledge, there have been no studies conducted on the effects of physical activity interventions with and without auditory stimuli on SBs.

Different patterns in vocal and motor SBs as a function of LC or OM were observed in Post-PA as well. When vocal and motor SBs were analyzed separately, OM results showed that increased SBs for Aidan were accounted for by increased vocal SBs. Decreases in motor SBs were observed following both OM and LC for Aidan. Unlike Aidan, increases in SBs of Blake following OM were attributed to increases in both vocal and motor SBs. Blake’s high motor SBs during PA OM may be a result of sensory deprivation. Consistent with Rapp (2004), OM increased the reinforcing value of Blake’s motor SBs. Rapp (2004) examined the effect of prior access to automatically reinforced SBs on the subsequent SBs in a 10-year-old boy with Down syndrome and intellectual disability. Two daily 30 min sessions (one in the morning and one in the afternoon) were used to measure SBs during a free operant (FO) condition. During this FO, the effects of environmental enrichment (EE) with 1) music, 2) music plus a guitar, and 3) music plus a guitar plus contingent music loss on SBs were evaluated. Results showed that SBs were always found to be lower during the second session of the day. This means prior access decreased later engagement in SBs. EE with music only increased SBs during both daily sessions. The presence of music as a preferred stimulus may have increased the reinforcing value of SBs. Similar to the Rapp (2004) study, balls used in OM for Blake served as reinforcers that were complementary to the production of his motor SBs. Therefore, one does not know how may have been affected SBs.
2. What are the effects of object manipulation and locomotor activities on heart rates of participants with ASDs?

The current study showed no overlaps in plotted heart rates between OM and LC. Therefore, the physical activities used in this study produced two different intensities. All three participants’ heart rates during LC were higher than OM. These results assured that LC in this study led the participants to be involved in more vigorous activity than OM. Therefore, this study succeeded in providing participants with two fundamentally different activities based on intensity. These results are consistent with Levinson and Reid (1993) in which they offered walking and jogging activities. Reported heart rates in their study were higher than the current study. One of the reasons for lower heart rates in the current study can be accounted for by the limited motor ability of participants. Low motor competence made it difficult for them to engage in vigorous activity. For example, when running speed was increased participants often fell down. A second reason was that the activity time was shorter than in the Levinson and Reid study. The five minutes of vigorous physical activity in the current study produced lower heart rates than 15 minutes of vigorous activity in the Levinson and Reid study. The current study did not continuously monitor heart rates throughout the activity due to the participants’ negative reactions toward the monitoring device. Studies have addressed difficulties in using heart rate monitoring devices for individuals with autism (e.g., Levinson & Reid, 1993; Oriel et al., 2011; Prupas & Reid, 2001). Oriel et al. (2011) reported increased challenging behaviors. In the current study the same issues were experienced. In order to overcome them a 2-week acclamation period with the device was conducted. Classroom teachers
and school staff were actively involved during the period by reinforcing participants to wear the device for at least a few seconds. Overall, heart rate monitoring was successful. However, on some occasions recording delays occurred due to overexcitement and device sensitivity associated with the finger size of participants. Because of occasional delays, and monitoring took place immediately following activity rather than during the activity, heart rates could have been underestimated. Levinson and Reid (1993) also reported that they failed to measure real-time heart rate due to their participants refusing to wear the device.

Despite limitations, this study demonstrated the participants experienced differential heart rates using a valid monitoring instrument. However, differing heart rates cannot be considered the sole reason of reduced SBs in Post-PA LC. For example, in LC session 7, Blake engaged in intense physical activity to the point where his heart rate increased to 180 bpm. During the activity, increased vocal SBs and decreased motor SBs were observed. Following the vigorous LC activity, his overall and motor SBs increased, indicating vigorous physical activity at a very high level could produce a deteriorating effect on SBs. His heart rate five minutes after activity was still at 138 bpm, higher than his average heart rate in PA LC. In general, heart rates of participants quickly returned to resting levels. Therefore, the heart rate results reported in the current study show different activity (OM and LC) intensities.

3. What are the effects of object manipulation and locomotor activities on-task behavior in the post-physical activity phase compared to the pre-physical activity phase?
Similar to the examination on the effects of OM and LC activities on SBs, changes in on-task behaviors as a function of OM and LC were examined. When a visual analysis for each participant’s data was conducted, a positive influence of LC activity in increasing on-task behaviors was found in two of the three participants. Aidan’s data show a great deal of overlaps between data points in OM and LC.

Unlike the results from the visual analysis, PND of LC for all participants revealed no LC intervention effects on on-task behaviors. When a second extreme data point in OM was selected, a strong LC intervention effect was found Only for Blake. This no or minimal effectiveness in LC for two participates can be interpreted in several ways.

First, a great deal of variability in on-task behavior changes for both OM and LC could be the potential reason for weak internal validity of LC intervention. Although it is not clear why such a large variability was shown, a further analysis of each participant’s engagement in particular items following OM or LC may be able to provide a potential reason for the results.

Second, since the selected items were all preferred items, high levels of on-task behaviors could be resulted. For example, Aidan’s high levels of on-task behaviors in both OM and LC produced non-distinctive effects of LC on on-task behaviors. In addition, free-access to preferred items might have carried over ‘satiation effect’ more quickly and this might have affected the results. Use of non-preferred items could provide a better insight for the question relative to any effects of OM or LC on on-task behaviors.
Third, measuring correct responding instead of on-task behavior could have been produced more stable data. Measuring on-task behaviors using multiple items coined with participant preference might have been produced unstable responses across the sessions.

4. What is the relationship between SBs and on-task behaviors observed in participants with ASDs?

Previous research (e.g., Kern & Covert, 1972; Koegel, Firestone, et al., 1974; Rosenthal-Malek & Mitchell, 1997) provides evidence of a potential inverse relationship between SBs and on-task behaviors. The current study also found similar evidence. Increased on-task behaviors were observed when SBs declined in two of the three participants. In particular, the average percent of SBs and task engagement for Participant 1 (Thomas) and Participant 3 (Blake) indicate that increased SBs following OM resulted in decreased on-task behaviors. On the other hand, decreased SBs following LC produced better task engagement. In fact, the use of the same play items by each participant throughout the study period was a concern because of potential satiation effects. Satiation effects seemed to result in low Post-PA task engagement because the items were already used in Pre-PA. However, higher task engagement in Post-PA LC can lead one to accept the positive effects of LC on both SBs and task engagement.

Participant 2 (Aidan), however, did not show such a clear inverse relationship. This was caused by high task engagement throughout all intervention phases. Task engagement was high regardless SB levels. In addition, the high percent engagement in on-task behaviors made it difficult to compare relationships between SBs and on-task behaviors different types of PA (OM & LC). However, no physical activity decreased on-
task behaviors. A study by Watters and Watters (1980) examined potential decreases in appropriate responding with decreases in SBs. Their results suggest that while no positive changes in on-task behaviors (i.e., academic performance) were observed physical activity did not have negative effects. Similar to the Watters and Watters study, no deterioration effects relative to on-task behaviors were found. Therefore, Aidan’s results can be interpreted as no deteriorate effects from both types of physical activities on task engagement.

In addition, in the current study a duration-based measure (percent engagement in on-task behaviors) was used as opposed to a frequency measure (number of correct responses). This was because it was not feasible to quantify the frequencies of correct responses because of the types of items in the study. A study by Oriel et al. (2011) measured percentages of correct responses (i.e., academic) and on-task behaviors before and after 15 minutes of running. They found significant improvement in correct responding in seven of the nine participants following the exercise condition but no significant differences for both on-task behavior and SBs.

The current study showed that some vocal and motor SBs can be compatible with some on-task behaviors. This was why high SBs and high on-task behaviors were occasionally found. In particular, vocal SBs were high when participants were highly engaged in tasks. While not included in the results section (see Appendix M), a separate analysis of vocal and motor SBs and on task behaviors showed a more apparent relationship. An inverse relationship was evident when only motor SBs were identified in
the analysis. If tasks involving vocal responses (e.g., counting or naming) were used, different results might have been found.

Implications

The results of this study indicate that five minutes of LC activity reduced SBs during a play phase that immediately followed it, compared to an identical play activity phase experienced immediately prior to LC activity. The OM activity phase did not affect SBs. On-task behaviors, were affected by the two types of physical activities, although the effects were not as evident when SBs were observed. Increased on-task behaviors were found immediately after the LC activity phase in two of the three participants. Participation in OM activity decreased on-task behaviors during a play phase that immediately followed by the OM activity. A number of physical activity intervention studies have been conducted to reduce SBs of individuals with ASDs. Even though studies have reported positive effects particularly with vigorous aerobic exercise, few of them provided recommendations for designing effective physical activity programs to promote the reduction of SBs.

Findings from this study suggest that selecting developmentally appropriate LC activities through activity preferences would facilitate active participation. When it comes to working with children with ASDs, it is important to ensure participants experience all components of the intervention as planned. In the current study, reported mean percent of on-task behaviors during physical activities were above 70% in both OM and LC (range, 70-96). Unlike previous studies that used jogging, the current study used various gross motor tasks in order to motivate the participants. Thus, in LC, participants
actively engaged in continuous and vigorous LC activity. Active participation was an important factor that produced positive results. Selection of motor tasks that facilitate children’s participation and enhance their motivation to move should be an important consideration. Previous studies have rarely reported treatment fidelity. This study used three 5 min-phases which facilitated rigorous experimental controls. The extent to which the participants experienced the components of a given intervention as planed and what activities took place prior to introducing the intervention components should be documented and reported. In addition, this study conducted a preference assessment and functional analysis prior to introducing physical activity intervention components. Depending on participant preferences and factors maintaining SBs, each participant may react differently to the intervention components. Many behavioral intervention studies have used such assessments. Identification of participant preferences as well as types of reinforcement for SBs through formal assessments should be used in future physical activity/education research. This study did not conduct a preference assessment for physical activity items. Use of preferred physical activity items may be able to provide stimuli that can satisfy each participant’s sensory needs. Future research should use preferred physical activity items to identify how item preference would impact the results of a given physical activity intervention. The results of this study provide several practical implications for practitioners who work with children with ASDs.

First, this study provided evidence that greater overlaps between motor tasks and motor SBs could lead to decreased motor SBs, especially while children are performing the PA tasks. Identifying matched motor tasks that are both appropriate and incompatible
with SBs seemed to suppress SBs and increase task engagement during physical activity. Mays, Beal-Alvarez, and Jolivette (2011) recommend that practitioners select movement tasks by understanding SBs in relation to sensory problems and how SBs interact with environmental variables. They suggest that those selection recommendations could help to find replaceable movement tasks for SBs. For example, tapping an object can be replaced with dribbling a ball. Similarly bouncing up and down can be replaced with jumping on trampoline. Finding replaceable movement tasks for SBs might also increase the likelihood students could receive positive reinforcement from the teacher.

Selection of movement tasks is important for controlling SBs. The positive results of overlapping motor repertoires between physical activities and reduced SBs have been reported in previous studies (e.g., Levinson & Reid, 1993; Watters & Watters, 1980). According to Rapp (2004) and Lang et al. (2010), providing items or activities that could naturally allow SBs to be evoked could decrease later engagement in SBs and increase functional behavior. Selection of motor tasks that are topographically and functionally similar to the SBs of students may provide them with the stimulations they need so that SBs are reduced during and after physical activity.

Another important implication for practitioners is the selection of OM equipment and activity. In this study increased SBs were observed during and following OM. These results were unexpected. Possible reasons for this may be that: 1) OM items stimulated the participants’ SBs; 2) participants had low OM competence, or 3) OM activities were less intense than LC activities. Implications for practitioners include carefully selecting OM items that do not serve to emit SBs. In addition, practitioners should carefully
consider how to arrange OM and LC tasks in their physical activity programs in a way that LC tasks can assist the enhancement of OM tasks. For example, Kern, Koegel, Dyer, et al. (1982) reported improved ball-playing as appropriate play behavior immediately following jogging. OM activities followed by LC activities may help students better engage in OM tasks. Even though the current study did not focus on longitudinal effects, a longitudinal approach with a comprehensive OM and LC program targeting both SBs and motor skill acquisition would be theoretically feasible based on the evidence found in the current and previous study and studies.

This study demonstrated that even brief engagements in LC activities can achieve positive changes in SBs given a 5-minute PA bout, considering attention spans and fitness levels of preschoolers. Study outcomes suggest that teachers could use several brief LC activity episodes throughout the day without substantial disruption in academic schedules. Studies on antecedent physical activities report that physical activity interventions could be easy to implement and do not interrupt regular school schedules (Powers et al., 1992; Rosenthal-Malek & Mitchell, 1997). Teachers can create an activity space in the classroom and embed brief periods of physical activity within the class day.

Study implications include a need for a structured physical activity program for young children with ASDs. Although many educational programs for young children with ASDs include physical therapy and occupational therapy, including systematic physical activity services in preschool is often neglected. Unstructured recess time potentially increases time for young children with ASDs to engage in SBs. This study found an inverse relation between SBs and on-task behaviors in two of the three
participants. For participant 2, physical activity did not produce detrimental effects on on-task behaviors. These results are consistent with previous studies that report decreased SBs and increased on-task behaviors. SBs in children with ASDs are not only socially stigmatizing (Repp, Singh, et al., 1991) or potentially dangerous to self and others (Matson, Mahan, Hess, Fodstad, & Neal, 2010) but also adversely impact learning (Koegel & Covert, 1972; Kern, Koegel, Dyer, et al., 1982; Lovaas, Litrownik, & Mann, 1971; Matson & Nebel-Schwalm, 2007; Sigafoos et al., 2003). Study results demonstrate that vigorous LC activity can increase on-task behaviors. Even though the tasks used in the current study were not academic in nature, attending to a given task or developing play skills are important to developing appropriate educational behaviors as well as enhancing independence (Elliott, Hall, & Soper, 1991; Koegel & Johnson, 1989; Scheerenberger, 1981). In addition, these skills may serve as a basis for using academic skills (Lang et al., 2010) in future physical activity studies. A common notion is that SBs often create barriers for social interactions with teachers and peers (Storey et al., 1984; Morrissey et al., 1992). Therefore, appropriately designed physical activity programs can reduce SBs and help children learn both motor skills and other educational tasks better.

Limitations of the Study

The study’s results might have been affected by the following limitations:

1. The inability to control locomotor and object manipulation activities outside the school setting or within the scheduled school settings.

2. The inability to control participant attendance during data collection.

3. The inability to continuously monitor heart rates throughout the activity.
4. Combining multiple types of SBs during coding and the use of multiple play items might have caused variability in both SB and on-task behavior data.

5. The 6-s partial interval scheme might not be able to fully represent actual duration and magnitude of target behaviors.

6. The multielement design used in this study might have represented undifferentiated responding due to carryover effects associated with the design even though picture cards were used to help the participant discriminate different activity types and phases.

7. On-task behaviors during play activities used in this study cannot be generalized to on-task behaviors during academic activities.

8. Physical activity items (e.g., trampoline, balls) were not selected through a preference assessment.

9. Inability to control scheduled activities before each participant had an intervention session even though the current study components were always implemented at consistent time in day throughout the entire study.

10. The results cannot be generalized to all preschoolers with ASDs.

Future Research

This study provides evidence that locomotor activity (LC) with relatively vigorous intensity positively affects SBs as well as on-task behaviors of preschool children with ASD. The following suggestions are made in order to obtain a better understanding of physical activity relative to stereotypic and on-task behaviors. Future studies should:

1. Manipulate dimensions of physical activity other than intensity such as duration,
frequency, distance and type (e.g., weight bearing activities, aquatics).

2. Examine the effects of OM and LC activities and SBs on academic performance.

3. Be conducted in peer group settings (with or without disabilities).

4. Include participants with the same or similar topographical characteristics of SBs and provide specific motor tasks matched to those topographies.

5. Examine the effects of physical activities for other types of SBs that are not maintained by automatic reinforcement.

6. Use continuous heart rate monitoring for entire test periods.

7. Include additional physiological or neurobiological measures such as hormonal profiles and brain activity.

8. Examine the longitudinal effects of physical activities such as improved fitness and motor competency along with increased functional behaviors.

9. Select participants with similar types of SBs and provide matched physical activity tasks to their SBs to compare the effects of physical activity on other types of SBs.

10. Utilize other designs that can show better experimental control than the multielement design used in the current study.

11. Use physical activity tasks that require vocal responses or provide auditory stimuli to see how those can affect vocal SBs.

12. Use a particular class activity that can take place immediately before the physical activity intervention to identify potential synergy effects or aggravating effects of the combination.
Conclusion

The purpose of the current study was to identify the effects of object manipulation (OM) and locomotor (LC) activities on stereotypic behaviors (SBs) and their relationship to on-task behaviors in three preschool children with autism. In order to identify the immediate effect of physical activities, three 5-min observation phases were conducted prior to (Pre-PA), during (PA), and following (Post-PA) either OM or LC activities. Using a multielement design, OM and LC were introduced in an alternating fashion individually to each participant. Only one type of activity (either OM or LC) was delivered per day. A 6-sec interval coding procedure was used to calculate the percentage of time each participant engaged in both SBs and on-task behaviors. The results demonstrated that decreases in SBs were observed when participants engaged in both PA and Post-PA LC. In contrast, the SBs of all participants increased immediately following OM (Post-PA). An inverse relationship between SBs and on-task behaviors was observed in two of the three participants. Inconsistent OM vocal SB responses were found, indicating that the vocal SBs of participants might have reacted differently to physical activities. Decreased SBs following LC (Post-PA) suggest that LC activities may have provided substitutable stimuli through environmental enrichment. Increased SBs following OM (Post-PA) indicate that OM activity (PA) may have temporarily reduce the SBs of two of the three participants but failed to decrease SBs following OM activity (Post-PA). Increased SBs during (PA) and following (Post-PA) OM were observed in two of the three participants. Increased and decreased SBs showed relatively consistent levels in two of the three participants when Post-PA was extended. Heart rates during LC
activities were increased compared to heart rates during OM activities. These results revealed that LC activities were more vigorous than OM activities supporting findings from previous studies (Celiberti et al., 1997; Kern, Koegel, & Dunlap, 1984; Levinson & Reid, 1993) that vigorous physical activities can reduce SBs. Overall, this study demonstrated that a physical activity intervention comprised of LC activity was found to be more effective than OM activity for reducing SBs. One of the strengths of this study was the demonstration of positive behavioral changes through physical activity (developmentally appropriate motor tasks). It was found that five minutes of LC activity could reduce SBs and increase on-task behaviors, while five minutes of OM activity could not. Results also provide information on how stimuli produced by OM and LC activities affect SBs. This study provided additional evidence to better understand the mechanism(s) of physical activities in reducing SBs and facilitating on-task behaviors.
References


Courchesne, E., Yeung-Courchesne, R., Press, G. A., Hesselink, J. R., & Jernigan,


Developmental Disabilities, 17, 135–143.


of single subject research: Methodology and validation. *Remedial and Special Education, 8*, 24-33.


Appendix A: Preschool Approval Letter
February 25, 2013

To Whom It May Concern,

My name is Sean Hanrahan and I am the director of the preschool at Oakstone Academy. We would be pleased to allow Jihyun Lee to conduct her dissertation study at our school. Jihyun is a doctoral student majoring in Adapted Physical Education, and she plans to study the effects of gross motor activities on behavior. Our population of children with Autism Spectrum Disorder will be the focus and I am excited to have our students take part as gross motor activities are a part of their daily routine. Jihyun’s study may well have a positive effect for all of our students and we look forward to having her at our school.

Thank you for your time,

Sean Hanrahan
Preschool Director
Appendix B: Behavioral and Social Sciences Human Subjects Institutional Review Board (IRB)
March 27, 2013

Protocol Number: 2012B0125
Protocol Title: EFFECTS OF VARIOUS GROSS MOTOR ACTIVITIES ON STEROTYPIC BEHAVIOR IN CHILDREN WITH AUTISM SPECTRUM DISORDERS, David Porretta, Jihyun Lee, School of Physical Activity & Educational Services

Type of Review: Continuing Review & Amendment—Expedited
Approval Date: March 19th, 2013
IRB Staff Contact: Shannon Ryan  Phone: 614-688-7920  Email: ryan.1189@osu.edu

Dear Dr. Porretta,

The Behavioral and Social Sciences IRB APPROVED the Continuing Review of the above referenced research.

Date of IRB Approval: March 19th, 2013
Date of IRB Approval Expiration: March 19th, 2014
Expedited Review Category: 6,7

The research has been approved for the inclusion of children (permission of one parent sufficient).

In addition, the IRB APPROVED the amendment request to amend the protocol dated 02/27/2013-- Add key personnel Linsey Sabelny and Joshua Garner; change children's age range to 3-5 years; use pulse oximeters to detect physical activity; revise recruitment letter and parental permission form to reflect proposed changes; add Social Validity Questionnaire and consent form for teachers; add research site (Oakstone Academy) on March 26th, 2013.

If applicable, informed consent (and HIPAA research authorization) must be obtained from subjects or their legally authorized representatives and documented prior to research involvement. The IRB-approved consent form and process must be used. Changes in the research (e.g., recruitment procedures, advertisements, enrollment numbers, etc.) or informed consent process must be approved by the IRB before they are implemented (except where necessary to eliminate apparent immediate hazards to subjects).

This approval is valid for one year from the date of IRB review when approval is granted or modifications are required. The approval will no longer be in effect on the date listed above as the IRB expiration date. A Continuing Review application must be approved within this interval to avoid expiration of IRB approval and cessation of all research activities. A final report must be provided to the IRB and all records relating to the research (including signed consent forms) must be retained and available for audit for at least 5 years after the research has ended.

It is the responsibility of all investigators and research staff to promptly report to the IRB any serious, unexpected and related adverse events and potential unanticipated problems involving risks to subjects or others.

This approval is issued under The Ohio State University’s OHRP Federalwide Assurance #00006378. All forms and procedures can be found on the ORRP website – www.orrp.osu.edu. Please feel free to contact the IRB staff contact listed above with any questions or concerns.

Steve Beck, PhD, Co-Chair
Behavioral and Social Sciences Institutional Review Board

hi-017-07 Exp Approval CR/AM
Version 05/18/10

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Appendix C: Participant Recruitment Letter and Parental Permission Form
Effects of Various Gross Motor Activities on Stereotypic behaviors in Children with Autism Spectrum Disorders

Physical activity has been shown to decrease stereotypic (e.g., body rocking, hand flapping) and/or challenging (e.g., aggression, tantrum) behaviors and increase on-task behaviors of children with ASD. As such, we would like to invite you to be part of a study in which we will be using two types of age appropriate physical activities, locomotor and object manipulation activities, in order to decrease stereotypic behaviors and increase task-oriented behaviors.

To participate in these studies, a potential participant must:

i. be 3-5 years old
ii. be diagnosed with autism, asperger, PDD-NOS, rett syndrome, or childhood disintegrative disorder typical of those with autism spectrum disorders
iii. exhibit frequent stereotypic behaviors (e.g., are hand flapping, body spinning or rocking, head rolling, spinning in circle, and etc.) or challenging behaviors (e.g., aggression, tantrum, self-injuries) that have been reported by their teachers and/or parents to interfere with their educational activities or social interaction with others, and
iv. enjoy physical activity such as ball playing, running, jumping
v. no history of epilepsy or seizures

Preference assessment will be conducted by a certified behavior analyst prior to the study in order to identify preferred play and physical activity items. The behavior analyst will also conduct functional analysis to identify factors maintaining the participant’s problem behaviors. Physical activity sessions will occur 3 to 5 days a week during your child’s normally scheduled school day and will last for 15 minutes (a 5-min pre-activity, a 5-min physical activity, a 5-min post-activity). During this time the activities that will be conducted as part of this study will be typical of those in which children would participate as part of his/her regular physical education or motor play programs. There will be an experienced motor development specialist to provide instruction to each participant at all times. The physical activities in this study can be categorized into two types- 1) locomotor and 2) object manipulation. Locomotor
activities will involve more continuous, vigorous body movements such as riding a tricycle, jumping on a trampoline, walking on an air-walker, bouncing on a bounce ball and so on. The object manipulation activities involve more discrete body movements and mild intensity compared to the locomotor activities. Examples of the object manipulation activities include throwing, catching, striking, and kicking. All of the activities and activity items will be age appropriate and selected based on the participants’ preference (preference assessment). It is expected that the entire study will be 8-12 weeks. Upon the completion of the study information regarding the results will be available upon the parents/guardians request. For further information or questions concerning this request, please contact either Dr.Porretta or Ms. Jihyun Lee. Their contact information appears on the attached Parental Permission Form.

If your child has met the participation criteria described above and you are interested in having him/her participate in the study, please sign, date, and return the attached Parental Permission Form. If you allow for the researcher to access your child’s school records to obtain official diagnoses, current medications if any, and level of social communication, and language skills, please sign, date, and return the attached Parental Permission Form.

Sincerely,

David L. Porretta, Ph.D.  
Professor and Principal Investigator

Jihyun Lee, M.S.  
Co-investigator
The Ohio State University Parental Permission
For Child’s Participation in Research

Study Title: Effects of Various Gross Motor Activities on Stereotypic behaviors in Children with Autism Spectrum Disorders
Researcher: David Porretta, Jihyun Lee

This is a parental permission form for research participation. It contains important information about this study and what to expect if you permit your child to participate.

Your child’s participation is voluntary.
Please consider the information carefully. Feel free to discuss the study with your friends and family and to ask questions before making your decision whether or not to permit your child to participate. If you permit your child to participate, you will be asked to sign this form and will receive a copy of the form.

Purpose:
Physical activities are known to be beneficial to reducing stereotypic and challenging behaviors of children with autism spectrum disorders (ASD). Unfortunately, effects of various types of gross motor activities on stereotypic or challenging behaviors and on-task behaviors of children with ASD have lacked appropriate detail and controls. Therefore, purpose of this study is to examine the effects of two physical activity conditions, 1) locomotor and 2) object manipulation activity, on stereotypic or challenging behaviors and on-task behaviors of children with ASD. The results of this study can help practitioners make appropriate instructional approaches and modifications.

Procedures/Tasks:
Data will be collected during a regularly scheduled school program during Spring Semester. Videotaping will take place so that behaviors can be analyzed at a later time.
Study participants will be engaged in 3 phases: 1) a preference assessment which aims to identify preferred play and physical activity items by each child that will be used during the intervention. Only age appropriate play and physical activity items will be include such as puzzles, coloring books, blocks, various types of balls, tricycle, scooter board, mini-trampoline, mini-steppers and so on; 2) a functional analysis of participants’ problem behaviors will be conducted in order to identify whether the participant’s problem behavior is related to attention seeking, avoiding demanding tasks, or adding sensory stimulus; 3) physical activity intervention (two types of physical activities)— a) locomotor activities that involve various items (e.g., tricycle, scooter board, trampoline) that can generate high intensity body movements (e.g., running, jumping), and 2) object manipulation activities that involve various gross motor tasks such as kicking, catching, striking, throwing, and so on. The locomotor activities will consist of continuous and vigorous movements compared to the object manipulation activities that involve discrete and mild intensity of body movements.
The actual physical activity session will last for 5 minutes. In addition, each participant’s behavior will be observed for 5 minutes before and after the physical activity while the child is engaging in various play tasks (e.g., puzzles, blocks). Each physical activity session will involve highly motivating child friendly activities because items will be selected based on each child’s preference. Upon completion of each session the child will be returned to class. During the physical activity, a fingertip pulse oximeter will be used. The device will help to confirm the intensity of the aforementioned physical activities.

**Duration:**
The total involvement will be 8 to 12 weeks. Each preference assessment or functional analysis session will last 10 minutes and only one session of each will be implemented for 2-3 weeks. Physical activity intervention will last a total of 5-8 weeks and each session will last for 15 minutes (a 5 min-pre-activity + a 5-min-actual physical activity + a 5 min-post-activity). Your child may leave the study at any time. If you or your child decides to stop participation in the study, there will be no penalty and neither you nor your child will lose any benefits to which you are otherwise entitled. Your decision will not affect your future relationship with The Ohio State University.

**Risks and Benefits:**
Aside from participating in regularly scheduled physical activities appropriate for your child there is no increased risk. Your child will participate in preferred activities with an experienced teacher in a motivating atmosphere. There will be adult supervision at all times by investigators experienced in working with children with disabilities and in making these activities fun and enjoyable. For additional safety an exercise mat will be used for the activity area. Children will be given repeated breaks as needed. The benefits are threefold: 1) children typically enjoy the attention and activity they get as part of the experience, 2) parents will be provided with information on the results of the study so they can better understand the effects of various activities on their child’s stereotypic/challenging behaviors and on-task behaviors, and 3) school administrators and teachers will be provided with information collected from the study to inform them about future physical activity instruction and programming.

**Confidentiality:**
Efforts will be made to keep your child’s study-related information confidential. However, there may be circumstances where this information must be released. For example, personal information regarding your child’s participation in this study may be disclosed if required by state law. Also, your child’s records may be reviewed by the following groups (as applicable to the research):

- Office for Human Research Protections or other federal, state, or international regulatory agencies;
- The Ohio State University Institutional Review Board or Office of Responsible Research Practices;
- The sponsor, if any, or agency (including the Food and Drug Administration for FDA-regulated research) supporting the study.

**Incentives:** Neither you nor your child will receive monetary compensation or other incentives for participating in the study.
Participant Rights:

You or your child may refuse to participate in this study without penalty or loss of benefits to which you are otherwise entitled. If you or your child is a student or employee at Ohio State, your decision will not affect your grades or employment status. If you and your child choose to participate in the study, you may discontinue participation at any time without penalty or loss of benefits. By signing this form, you do not give up any personal legal rights your child may have as a participant in this study.

An Institutional Review Board responsible for human subjects research at The Ohio State University reviewed this research project and found it to be acceptable, according to applicable state and federal regulations and University policies designed to protect the rights and welfare of participants in research.

Contacts and Questions: For questions, concerns, or complaints about the study you may contact

Dr. David L. Porretta                Jihyun Lee
A244 PAES Building                 A216 PAES Building
305 W.17th Ave                    305 W.17th Ave
Columbus, OH. 43210                Columbus, OH 43210
porretta.1@osu.edu              lee.3582@osu.edu
614-292-0849                        614-315-6622

For questions about your child’s rights as a participant in this study or to discuss other study-related concerns or complaints with someone who is not part of the research team, you may contact Ms. Sandra Meadows in the Office of Responsible Research Practices at 1-800-678-6251. If your child is injured as a result of participating in this study or for questions about a study-related injury, you may contact

Dr. David L. Porretta                Jihyun Lee
A244 PAES Building                 A216 PAES Building
305 W.17th Ave                    305 W.17th Ave
Columbus, OH. 43210                Columbus, OH 43210
porretta.1@osu.edu              lee.3582@osu.edu
614-292-0849                        614-315-6622
Signing the Parental Permission Form

I have read (or someone has read to me) this form and I am aware that I am being asked to provide permission for my child to participate in a research study. I have had the opportunity to ask questions and have had them answered to my satisfaction. I voluntarily agree to permit my child to participate in this study.

I am not giving up any legal rights by signing this form. I will be given a copy of this form.

______________________________
Printed name of subject

______________________________  ______________________________
Printed name of person authorized to provide permission for subject  Signature of person authorized to provide permission for subject

______________ AM/PM
Relationship to the subject

______________________________  ______________________________
Date and time  AM/PM

Permission to Access Child’s School Records

I understand that by completing and submitting this form, the researchers can access information on diagnoses, medications, and assessment results on language, social, and communication skills from my child's school and that researchers have no further obligation to contact me on a case-by-case basis to request my consent for the information.

I am not giving up any legal rights by signing this form. I will be given a copy of this form.

______________________________
Printed name of subject

______________________________  ______________________________
Printed name of person authorized to provide permission for subject  Signature of person authorized to provide permission for subject

______________ AM/PM
Relationship to the subject

______________________________  ______________________________
Date and time  AM/PM

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**Investigator/Research Staff Use Only**

I have explained the research to the participant or his/her representative before requesting the signature(s) above. There are no blanks in this document. A copy of this form has been given to the participant or his/her representative.

<table>
<thead>
<tr>
<th>Printed name of person obtaining consent</th>
<th>Signature of person obtaining consent</th>
<th>AM/PM</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
<td>Date and time</td>
</tr>
</tbody>
</table>
Appendix D: Play Items and Definitions for Task Engagement
<table>
<thead>
<tr>
<th>Items</th>
<th>Definitions of Engagement</th>
<th>Definition of Non-engagement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Reading Books</td>
<td>Looking at pictures/words/covers</td>
<td>Putting the book in the mouth</td>
</tr>
<tr>
<td></td>
<td>Pointing pictures/words/covers</td>
<td>Spinning the book</td>
</tr>
<tr>
<td></td>
<td>Naming an object/color in the page</td>
<td>Placing the book in front of the body but not attending/looking</td>
</tr>
<tr>
<td>Playing with Blocks</td>
<td>Building/putting blocks together</td>
<td>Tapping desk using a block</td>
</tr>
<tr>
<td></td>
<td>Move blocks on surface of desk slowly</td>
<td>Wiping motion with a block</td>
</tr>
<tr>
<td></td>
<td>Looking at a block at different angles (7-10 inches away from the face)</td>
<td>Mouthing a block</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Touching/wiping body park using a block</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Placing a block in front of eyes (less than 5 inches away from his eyes) for longer than 3-s</td>
</tr>
<tr>
<td>Playing with Cars</td>
<td>Moving a car with a hand to different directions</td>
<td>Tapping desk using a car</td>
</tr>
<tr>
<td></td>
<td>Looking at car at different angles (7-10 inches away from the face)</td>
<td>Wiping motion with a block</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Mouthing a car</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Spinning a car wheel</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Placing a car in front of eyes (less than 5 inches away from his eyes) for longer than 3-s</td>
</tr>
<tr>
<td>Playing with Magnets</td>
<td>Trying to put/putting magnets together</td>
<td>Tapping desk using a magnet</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Mouthing a magnet</td>
</tr>
<tr>
<td>Playing with Puzzles</td>
<td>Manipulating a puzzle piece</td>
<td>Tapping/wiping desk using a puzzle piece</td>
</tr>
<tr>
<td></td>
<td>Trying to place/placing a puzzle piece</td>
<td>Spinning a puzzle piece</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Mouthing a puzzle piece</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Placing a puzzle piece in front of eyes (less than 5 inches away from his eyes) for longer than 3-s</td>
</tr>
</tbody>
</table>
**Items for Each Participant**

<table>
<thead>
<tr>
<th>Participant</th>
<th>Items</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thomas</td>
<td>Cars/Trains, Blocks (wooden blocks, mega blocks), Magnets, Puzzles</td>
</tr>
</tbody>
</table>
<pre><code>      | (cars, alphabet)                                                    |
</code></pre>
<p>| Aidan       | Books, Puzzle (alphabet), Blocks (foam blocks), Magnets              |
| Blake       | Truck, Color Matching Folder, Magnets, Blocks (mega blocks), Puzzle  |
| (cars)                                                             |</p>

*The same items are used in both Pre-Physical Activity and Post-Physical Activity*
Appendix E: Locomotor and Object Manipulation Activity Items and Definitions of Task Engagement
### Activity Items

<table>
<thead>
<tr>
<th>Trampoline</th>
<th>Roller tunnel</th>
<th>Scooter</th>
</tr>
</thead>
<tbody>
<tr>
<td><img src="image1.png" alt="Trampoline" /></td>
<td><img src="image2.png" alt="Roller tunnel" /></td>
<td><img src="image3.png" alt="Scooter" /></td>
</tr>
</tbody>
</table>

### Activities & Definitions

<table>
<thead>
<tr>
<th>LC Activity</th>
<th>Definitions of Engagement</th>
<th>Non-example</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jumping on Trampoline</td>
<td>Moving, or jumping on a trampoline landing their foot or feet</td>
<td>Sitting on trampoline</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Bouncing on bottom more than two consecutive times</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Standing on feet for longer than 3-s</td>
</tr>
<tr>
<td>Running</td>
<td>Moving body forward on feet fast not having feet on the ground at the same time</td>
<td>Walking for longer than 3-s</td>
</tr>
<tr>
<td></td>
<td>Climbing up and down on feet non-stop</td>
<td>Sit on stairs</td>
</tr>
<tr>
<td>Crawling in/on a Roller Tunnel</td>
<td>Moving on the hands and knees toward a roller tunnel to go through</td>
<td>Having both feet on the ground at the same time (e.g., standing)</td>
</tr>
<tr>
<td></td>
<td>Creeping through a roller tunnel</td>
<td></td>
</tr>
<tr>
<td></td>
<td>Moving forward on a roll in a prone position</td>
<td></td>
</tr>
<tr>
<td>Wheelbarrow (hand-walking)</td>
<td>Walking/moving on the hands while the legs are held up by the investigator</td>
<td>When hand(s) is(are) not in contact with the floor (e.g., laying on stomach or back)</td>
</tr>
<tr>
<td></td>
<td></td>
<td>Kicking the investigator</td>
</tr>
</tbody>
</table>
Scooting

Scooting self on a scooter using one of 3 positions; prone (on tummy), supine (on back), and in sitting (on bottom) using either hands or legs

Standing or laying on scooter
Sitting on scooter for longer than 3-s

**LC Activities for Each Participant**

<table>
<thead>
<tr>
<th>Participant</th>
<th>LC activity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thomas</td>
<td>Running, Jumping, Crawling, Scooting</td>
</tr>
<tr>
<td>Aidan</td>
<td>Running, Jumping, Crawling, Wheelbarrow</td>
</tr>
<tr>
<td>Blake</td>
<td>Running, Jumping, Crawling</td>
</tr>
</tbody>
</table>
Object Manipulation (OM) activities

*Activity Items*

<table>
<thead>
<tr>
<th>Activity</th>
<th>Items</th>
</tr>
</thead>
<tbody>
<tr>
<td>Beach Ball</td>
<td>Playground Ball</td>
</tr>
<tr>
<td>Carnibal Ball Game Net</td>
<td>Beanbags</td>
</tr>
<tr>
<td>Bowling Pins</td>
<td>Foam Balls (small)</td>
</tr>
<tr>
<td>Cage Ball</td>
<td>Sensory Ball</td>
</tr>
<tr>
<td>Foam Balls (medium)</td>
<td></td>
</tr>
</tbody>
</table>
### Activities & Definitions

<table>
<thead>
<tr>
<th>OM Activity</th>
<th>Definitions of Engagement</th>
<th>Non-example</th>
</tr>
</thead>
<tbody>
<tr>
<td>Throwing</td>
<td>Using hand(s), passing a ball/beanbag to the investigator. Using hand(s) dropping, tossing, or throwing ball/beanbag toward ceiling, floor, or an object</td>
<td>Not manipulation or hugging the ball for longer than 3-s Sitting on a ball</td>
</tr>
<tr>
<td>Catching</td>
<td>Using hand(s), stopping/grabbing a ball tossed by the investigator. Using hand(s), trying to stop/grab a ball tossed by the investigator. Any contact between ball and hand(s) when the ball is tossed by investigator</td>
<td>No attempt to stop/grab the tossed ball (no arm(s) reaching forward)</td>
</tr>
<tr>
<td>Bouncing</td>
<td>Hitting/tapping a beach ball toward the floor</td>
<td>Not manipulation or hugging the ball for longer than 3-s Sitting on a ball Hitting the investigator</td>
</tr>
<tr>
<td>Rolling</td>
<td>Pushing a ball toward the investigator in a standing position or a sitting position Pushing a ball toward bowling pins Assisted rolling</td>
<td>Not manipulation or hugging the ball for longer than 3-s Sitting on a ball Touch the ball with foot or feet in a laying down position</td>
</tr>
<tr>
<td>Placing balls into basket</td>
<td>Transfer/Tossing a ball with hand(s) into a mini-basketball hoop</td>
<td>Sitting on the basketball hoop Putting hand(s) in the basket without a ball</td>
</tr>
</tbody>
</table>

### OM Activities for Each Participant

<table>
<thead>
<tr>
<th>Participant</th>
<th>OM activity</th>
</tr>
</thead>
<tbody>
<tr>
<td>Thomas</td>
<td>Throwing, Catching, Bouncing, Putting ball into basket</td>
</tr>
<tr>
<td>Aidan</td>
<td>Throwing, Catching, Rolling</td>
</tr>
<tr>
<td>Blake</td>
<td>Throwing, Catching, Putting ball into basket</td>
</tr>
</tbody>
</table>
Appendix F: Coding Sheet for Stereotypic Behaviors and On-task Behaviors
Participant: __________________ Observer: __________________

Date and Time: ________________ Condition: _________________

Stereotypic Behaviors (SBs):
________________________________________________________________________

On-task Behaviors:
________________________________________________________________________

Circle the following during the record phase of each interval:
√ (checkmark) if and when the target SBs occur.
+ (plus sign) if and when the participant demonstrates task engagement
O (zero sign) if and when the child is not required to actively participate in a task and/or
is doing what he is supposed to do (ex. transition, listening to what the investigator is saying)

*If the target behavior occurs at any point during the interval then the √ should be the only mark circled. The O should only be marked in an interval in which the child is not required to perform any activity and is NOT displaying any of the target behaviors.

<table>
<thead>
<tr>
<th>I</th>
<th>B</th>
<th>I</th>
<th>B</th>
<th>I</th>
<th>B</th>
<th>I</th>
<th>B</th>
<th>I</th>
<th>B</th>
</tr>
</thead>
<tbody>
<tr>
<td>10</td>
<td>√</td>
<td>+</td>
<td>O</td>
<td>10</td>
<td>√</td>
<td>+</td>
<td>O</td>
<td>10</td>
<td>√</td>
</tr>
<tr>
<td>20</td>
<td>√</td>
<td>+</td>
<td>O</td>
<td>20</td>
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I= interval, B= behavior
Appendix G: Photos of Study Areas
Area for Pre-PA, Post-PA and functional analysis

Area for PA
Appendix H: Coding Sheet for Preference Assessment
Appendix I: Functional Analysis – Procedural Description of Four Assessment Conditions
*All descriptions were directly retrieved from Iwata et al. (1982/1994; 2000) except the term 'SBs.'*

**Attention Condition**

**Purpose**

This condition is designed to determine whether the target behavior is maintained by contingent attention delivered by a therapist. The condition involves remaining in a room with a child and ignoring all child behavior, except for the target behavior (SBs) which is followed by attention.

**How to Conduct a Session**

1. Begin a session by directing the child toward the leisure materials that are present in the room. Tell the child that he or she should play with the toys while you do some work.
2. After issuing the initial instruction, move away from the child, sit in another chair, read or do some paperwork (or pretend to do so), and completely ignore all behaviors exhibited by the child except as noted below.
3. If the target behavior does not occur during the session, you will ignore the child for the entire session. Someone will inform you when the session is over.
4. If any behaviors other than the target behavior occur, ignore these also. Examples include appropriate behaviors (e.g., playing with the toys, smiling at you, or any attempts to talk to you or to interact with you in an appropriate manner) and inappropriate behaviors other than the target behavior (e.g., screaming, throwing materials, running around the room, aggression, etc.).
5. The only time you will attend to the child is when he or she engages in the target behavior. If the child exhibits the target behavior at any time during the session, do the following: (a) Go over to the child and verbally express concern and disapproval. For example, you could say something like, “Stop that, you’re going to hurt your- self,” “[Name], you shouldn’t hit yourself; play with your toys,” “[Name], I don’t want you to do that; you’re going to get hurt,” or something similar. (b) While you express concern, briefly touch the child’s arm,
place your hand on the child’s shoulder, or physically block the hitting response, but do not physically restrain the child. The general idea is to express concern, briefly interrupt the behavior, and calm the child. Do not shout at the child and do not handle the child roughly.

6. After a target behavior occurs and you have responded as indicated above (Step 5), resume ignoring the child until another target behavior occurs or until the session is over.

**Demand (Escape) Condition**

*Purpose*

This condition is designed to determine whether the target behavior is maintained by escape from task demands. The condition involves presenting a series of instructional trials to a child. Compliance produces praise, noncompliance produces a series of prompts, and occurrence of the target behavior immediately terminates the trial.

*How to Conduct a Session*

1. Begin a session with you and the child seated at a table. Using the materials that are available, you will implement a series of trials to teach the child to perform a task. The task selected for this simulation is putting blocks in a bucket.

2. Activate a stopwatch at the beginning of the session. At the beginning of every 30-s interval (starting at 0), you will initiate an instructional trial. Thus, there will be approximately 10 trials during a 5-min session. Begin each training trial with the bucket and a block on the table in front of the child. The sequence to be used during each trial is as follows: (a) First deliver a clear instruction to the child, such as “[Name], put the block in the bucket.” If the child performs the response within 5 s (count to 5 slowly to determine this), or at least begins to initiate the response during that time, deliver praise (e.g., say “nice job,” “that’s great,” “good,” etc.) when the child has finished. (b) If the child does not perform the response within 5 s, repeat the instruction and simultaneously demonstrate the response (i.e., you put a block in the bucket). If, following this demonstration, the child performs the response in 5 s, deliver praise as noted above. (c) If the child
does not perform the response within 5 s of your demonstration, repeat the instruction again and simultaneously provide physical assistance. That is, use your hands to help the child pick up the block and put it in the bucket. Do not deliver praise if you used physical assistance. (d) If, at any time during this sequence, the child emits the target behavior, immediately terminate the trial. Remove the materials from the table, turn away from the child, and ignore the child until it is time to begin a new trial. (e) If the child emits other inappropriate behaviors (screaming, throwing things, aggression, etc.), continue with the sequence; do not terminate the trial when these responses occur.

3. Repeat the above sequence after 30 s have elapsed since the trial began, and continue until the session is over.

**Play Condition**

*Purpose*

This is designed to be a general control condition, in which no demands are placed on the child, continuous access to preferred physical activity items is available, and attention is delivered frequently independent of the child’s behavior.

*How to Conduct a Session*

1. Begin a session by activating a stopwatch and directing the child toward the leisure materials that are present in the room. You may say something like, “Here are some nice toys; why don’t you play with them for a while?” or “Would you like to play with these toys?” (as you hand one to the child), or anything similar.

2. At least once every 30 s, deliver some form of attention to the child. For example, you can tell the child that he or she is playing nicely, ask if he or she is having fun, and so forth. You can also hand the child another toy, pat the child briefly on the shoulder, or smile at the child. The general idea is to provide some type of friendly, nondemanding interaction (lasting about 5 s) at 30-s intervals.

3. If the child attempts to interact with you appropriately (e.g., asks for something, hands you a toy, etc.), reciprocate.

4. If the child emits any form of inappropriate behavior, including the target
behavior, do not deliver attention.

5. If the target behavior occurs precisely at the end of a 30-s interval (just as you are about to deliver attention), do not deliver attention. Instead, wait until the behavior has stopped for 5 s, then deliver attention.

**Alone condition**

*Purpose:*

This condition is a test condition for behavioral persistence in the absence of social stimulation (automatic reinforcement). The alone condition is highly salient for the absence of demands (Kahng & Iwata, 1998).

*Procedure:*

The child is placed in the space alone, without access to toys or any other materials that might serve as external sources of stimulation. No attention or other programmed consequences are arranged.
Appendix J: Coding Sheet for Functional Analysis
Participant: __________________ Observer: ___________________

Target Stereotypic Behaviors (SBs):

√ (checkmark) if and when the target SBs occur during the record phase (every 10th second during a 5-min session) of each interval. Observe the behavior every 10th second and code the behavior at the 11th second (e.g., 11sec, 21sec, 31sec, etc.)

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Appendix K: Treatment Fidelity Checklist
Check if/when observed the following items:

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<td></td>
<td>During Pre-and Post-PA and PA conditions, no praise was delivered</td>
</tr>
<tr>
<td></td>
<td>During PA condition, investigator verbally and physically prompted the participant to engage with the activity items every 5-s when no engagement was observed</td>
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<tr>
<td></td>
<td>During PA condition, investigator provided clear, explicit verbal instruction</td>
</tr>
<tr>
<td></td>
<td>During PA condition, investigator provided clear, explicit activity demonstration</td>
</tr>
<tr>
<td></td>
<td>During Pre-and Post-PA and PA conditions, investigator did not intervene SBs</td>
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<tr>
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<td>Transition to the next condition was minimal (less than 1 min)</td>
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<td>Heart rate monitoring was immediately following a PA condition</td>
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<td>Each condition lasted for 5 minutes</td>
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<td>The same items were used in Pre-and Post PA conditions</td>
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<td></td>
<td>Participant spent about an equal amount of time per item/activity</td>
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Appendix L: Social Validity Questionnaire
Please view the video and then circle one of the five choices that best describes the extent to which you agree or disagree with each of the statements below.

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<tbody>
<tr>
<td>1.</td>
<td>The student is more engaged in play tasks after the physical activity session compared to before the physical activity session.</td>
<td>Strongly Disagree</td>
<td>Disagree</td>
<td>Neutral</td>
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<tr>
<td>2.</td>
<td>The student is more engaged in problem behaviors after the physical activity session compared to before the physical activity session.</td>
<td>Strongly Disagree</td>
<td>Disagree</td>
<td>Neutral</td>
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<tr>
<td>3.</td>
<td>The student appears to have a positive effect during the physical activity session (e.g., smiling, laughing, engaging)</td>
<td>Strongly Disagree</td>
<td>Disagree</td>
<td>Neutral</td>
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<tr>
<td>4.</td>
<td>I find the physical activity intervention used in this study to be an acceptable way of dealing with the child's problem behaviors.</td>
<td>Strongly Disagree</td>
<td>Disagree</td>
<td>Neutral</td>
</tr>
<tr>
<td>5.</td>
<td>I would be willing to use this intervention procedure if I had to change the child's problem behaviors.</td>
<td>Strongly Disagree</td>
<td>Disagree</td>
<td>Neutral</td>
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<tr>
<td>6.</td>
<td>I believe this physical activity intervention is likely to be effective.</td>
<td>Strongly Disagree</td>
<td>Disagree</td>
<td>Neutral</td>
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<td>7.</td>
<td>I believe the child will experience discomfort during this physical activity intervention.</td>
<td>Strongly Disagree</td>
<td>Disagree</td>
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<td>8.</td>
<td>Overall, I have a positive reaction to this intervention.</td>
<td>Strongly Disagree</td>
<td>Disagree</td>
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Appendix M: Participants’ Detailed Intervention Data
Thomas (Participant 1)

Object Manipulation Activity Results for Thomas. Percentages for Total, Vocal, and Motor Stereotypic Behaviors (SBs) and On-task Behaviors and Mean Beats Per Minute (bpm) for Heart Rate. Pre=Pre Physical Activity; PA=Physical Activity; Post=Post Physical Activity.

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<th>Motor</th>
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Locomotor Activity Results for Thomas. Percentages for Total, Vocal, and Motor Stereotypic Behaviors (SBs) and On-task Behaviors and Mean Beats Per Minute (bpm) for Heart Rate. Pre=Pre Physical Activity; PA=Physical Activity; Post=Post Physical Activity.

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**Aidan (Participant 2)**

Object Manipulation Activity Results for Aidan. Percentages for Total, Vocal, and Motor Stereotypic Behaviors (SBs) and On-task Behaviors and Mean Beats Per Minute (bpm) for Heart Rate. Pre=Pre Physical Activity; PA=Physical Activity; Post=Post Physical Activity.

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Locomotor Activity Results for Aidan. Percentages for Total, Vocal, and Motor Stereotypic Behaviors (SBs) and On-task Behaviors and Mean Beats Per Minute (bpm) for Heart Rate. Pre=Pre Physical Activity; PA=Physical Activity; Post=Post Physical Activity.

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Blake (Participant 3)

Object Manipulation Activity Results for Blake. Percentages for Total, Vocal, and Motor Stereotypic Behaviors (SBs) and On-task Behaviors and Mean Beats Per Minute (bpm) for Heart Rate. Pre=Pre Physical Activity; PA=Physical Activity; Post=Post Physical Activity.

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Locomotor Activity Results for Blake. Percentages for Total, Vocal, and Motor Stereotypic Behaviors (SBs) and On-task Behaviors and Mean Beats Per Minute (bpm) for Heart Rate. Pre=Pre Physical Activity; PA=Physical Activity; Post=Post Physical Activity.

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Total  | Pre   | 46  | 31    | 27    | 54      | 87         |
|        | PA    | 50  | 40    | 5     | 96      | 139        |
|        | Post  | 29  | 16    | 15    | 68      | 95         |