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Skill Acquisition and Behavior Change Following an Exercise Bout in Children with Autism Spectrum Disorder

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A thesis submitted to the faculty of
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Master of Science

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ABSTRACT

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The purpose of the study was to determine if antecedent bouts of exercise, through the means of a basketball practice, are beneficial to 5 children aged 8 to 11 with autism spectrum disorder (ASD) in decreasing competing behaviors (e.g., stereotypy, disruptive behaviors). Additionally, basketball skill mastery was measured. Antecedent exercise was corroborated by measuring heart rate. The results of the study indicate that antecedent exercise decreased disruptive behaviors and had no effect on stereotypic behaviors. Of the 5 participants, 4 of them had heart rate levels that indicated they were engaged in moderate to vigorous physical activity. All 5 participants increased in their basketball skill mastery. These findings suggest that children with ASD would benefit from antecedent exercise to decrease disruptive behaviors. They also have the ability to acquire motor skills in order join sports programs and participate in athletics along with typically developing peers.

Keywords: autism, antecedent exercise, behavior, skill acquisition

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DESCRIPTION OF THESIS STRUCTURE

The structure of this thesis, Skill Acquisition and Behavior Change Following an Exercise Bout in Children with Autism Spectrum Disorder, is presented in a hybrid format which meets both traditional and journal publication formatting requirements. The beginning pages of the thesis meet university standards for thesis submissions. The latter pages are formatted in a more "journal-ready" manner. In Appendix A, readers can find the extended literature review. Additional resources included in the document include: Task Analysis and Treatment Fidelity, Behavior Observation Form, Skill Observation Form, Treatment Fidelity Checklist, and Parent Permission Form (Appendices B-F).

Introduction

Childhood obesity is the number one health concern among parents in the United States with over one-third of children being classified as either overweight or obese (Corvey, Menear, Preskitt, Goldfarb, & Menachemi, 2016; Kist et al., 2015; Tyler, MacDonald, & Menear, 2014; Zuckerman, Hill, Guion, Voltolina, & Fombonne, 2014). The World Health Organization suggests that children aged 5 to 17 accumulate 60 minutes of moderate-to-vigorous physical activity every day (Füssenich et al., 2016). Moderate-to-vigorous physical activity is defined as 64% of maximal heart rate to 94% of maximal heart rate efforts (Medicine, 2013). Heart rate can be used to determine the amount of work that was done during an exercise bout. In 150 Caucasian children aged 7 years 6 months to 12 years 9 months, mean resting heart rates of 106 beats per minute (BPM) , 96 BPM, and 95 BPM for males, and 101 BPM, and 96 BPM in females were measured (Washington, van Gundy, Cohen, Sondheimer, & Wolfe, 1988). Maximal heart rate values post exercise testing included 191 BPM, 194 BPM, and 193 BPM in males, and 196 BPM in females (Washington et al., 1988). Average recovery heart rates in males were 133 BPM, 138 BPM, and 148 BPM, and in females, recovery heart rates were 142 BPM, 155 BPM, 160 BPM. Based on the American College of Sports Medicine (ACSM) definition of moderate-to-vigorous exercise, children should exercise at rates ranging from 120 to 176 BPM (Medicine, 2013; Washington et al., 1988).

Autism spectrum disorder (ASD) affects 16.8 per 1,000, or 1 in every 59 children, who are 8 years of age (Baio et al., 2018; Christensen et al., 2016). According to the Diagnostic and Statistical Manual of Mental Disorders Fifth edition (DSM-V), ASD is diagnosed as the child has: “persistent deficits in social communication and social interaction across multiple contexts,” and “restricted, repetitive patterns of behavior, interests, or activities,” and when these symptoms

present themselves early in development, and are not better explained by other intellectual disabilities (Association, 2013). Children with ASD are at a particularly high risk of being overweight or obese and are more likely to engage in more sedentary behaviors (Corvey et al., 2016; Must, Phillips, Curtin, & Bandini, 2015; Tyler et al., 2014). Obesity is also suggested to be affecting children with ASD at a younger age and more severely (Zuckerman et al., 2014).

Physical activity has many physical, emotional, psychological, and behavioral benefits. Research shows that aerobic moderate-to-vigorous exercise in children promotes executive function of the brain or effortful and goal-directed cognition and behavior, as well as increases physical fitness (Best, 2010; Tyler et al., 2014). Children with ASD are less likely to engage in physical activity and tend to be less physically fit than typically developed peers (Tyler et al., 2014). There are several perceived barriers to physical activity experienced by children with ASD such as behavioral problems, poor motor skills, and the tendency to prefer to participate in screen time (Must et al., 2015). As the number of parent perceived barriers to physical activity increases for children with ASD, the amount of screen time increases and the amount of physical activity decreases (Must et al., 2015). Compared to typically developed peers, children with ASD are less physically fit in the strength domain (Tyler et al., 2014). Participation in exercise programs can lead to increases in physical fitness in children with ASD including increases in strength and aerobic capacity, bringing them up to similar levels as typically developed peers (Pace & Bricout, 2015; Tyler et al., 2014).

Exercise has been shown to positively affect both the negative and positive behaviors in those diagnosed with ASD. A variety of different exercises have been used as antecedent interventions including: jogging, walking, biking, karate, swimming, weight lifting, stretching, yoga, dance, horseback riding, roller skating, trampoline jumping, utilizing a therapy ball, using

a scooter board, and using moon shoes (Bahrami, Movahedi, Marandi, & Abedi, 2012; Bremer, Crozier, & Lloyd, 2016; Celiberti, Bobo, Kelly, Harris, & Handleman, 1997; Kern, Koegel, & Dunlap, 1984; Kern, Koegel, Dyer, Blew, & Fenton, 1982; Lang et al., 2010; Levinson & Reid, 1992; Losinski, Cook, Hirsch, & Sanders, 2017; Morrison, Roscoe, & Atwell, 2011; Movahedi, Bahrami, Marandi, & Abedi, 2013; Neely, Rispoli, Gerow, & Ninci, 2015; Nicholson, Kehle, Bray, & Heest, 2011; Oriel, George, Peckus, & Semon, 2011; Petrus et al., 2008; Power, Thibadeau, & Rose, 1992; Prupas & Reid, 2001; Sowa & Meulenbroek, 2012). Early research done on the effects of antecedent exercise yielded positive results and noted that brief jogging sessions produced decreases in post-session engagement in self-stimulatory behaviors while increasing positive behaviors such as academic responding, being on-task, appropriate ball-play, and general interest in school-related tasks (Kern et al., 1982). More recent research has looked at how antecedent exercise affects not only stereotypic behaviors but academic engagement and social dysfunction as well and it has been shown that antecedent exercise increases academic engagement (Nicholson et al., 2011). Literature reviews on antecedent exercise examined the effects on various types of behaviors. The reviews all concluded that there is not enough evidence in the field of antecedent exercise but that antecedent exercise has short-term effects such as decreasing stereotypic behaviors and increasing social-emotional functioning, cognition, and attention (Bremer et al., 2016; Lang et al., 2010; Petrus et al., 2008; Sowa & Meulenbroek, 2012).

Some antecedent exercises, such as jumping on a trampoline until satiation, could fulfill the function of stereotypic behaviors, thus why heart rate is an important measure in corroborating whether exercise was completed or not (Neely et al., 2015). Other studies have utilized increased breathing rate and slightly flushed face to indicate that the child is engaging in

a state of mildly strenuous exercise (Kern et al., 1982). Each child could experience an increased breathing rate and flushed face at different levels of exertion. Some children become flushed right away while exercising and others might take a long time to become flushed. In future research a more scientific method, such as heart rate, might be used to determine level of exertion for the child. An exercise intervention that includes jogging, specifically one with sport skill performance, and heart rate monitoring, would increase the validity of antecedent exercise as an intervention for decreasing competing behaviors and increasing positive behaviors.

Sport participation can result in various social benefits for children with ASD (Ohrberg, 2013). Generally, team sport participation has been shown to decrease mental health problems in teenagers and children (Eime, Young, Harvey, Charity, & Payne, 2013). Team sport involvement increases feelings of social acceptance and reduces shyness and anxiety (Eime et al., 2013). Special Olympics involvement has been shown to reduce stress, increase quality of life, and increase self-esteem in individuals with intellectual disabilities (Robertson & Emerson, 2010). Robertson and Emerson (2010) found that individuals involved in Special Olympics report higher scores in their relationships than those who do not participate suggesting social benefits. Similarly teaching children with autism a sport or athletic activity increases positive social behaviors and decreases antisocial behavior problems (Movahedi et al., 2013; Pan, 2010).

Relatively few studies have been done concerning the skill acquisition of children with ASD in athletics. It was found that reinforcement, task analysis, and physical prompting in particular were important for motor skill improvement in people with ASD (Reid, Collier, & Cauchon, 1991). An additional study showed that teaching individual swimming skills to preschoolers with ASD is possible if the child is taught the skill through direct instruction and the instruction and expectations are paired to his or her unique skill level (Prupas, Harvey, &

Benjamin, 2006). Additionally, if parent instruction and guidance is reinforced by a coach, this solidifies skill development of the child (Prupas et al., 2006). Extremely specific task cues help the children with ASD be more successful in athletic skills (Chu & Pan, 2012). It has also been shown that the mastery of the athletic skills, and gameplay rules, allows children with ASD to increase in their interactions with typical peers (Miltenberger & Charlop, 2014).

There are some contraindications for exercise in children with ASD such as impairments in movement skills, and low heart rate response. Approximately 50-70% of children with ASD have movement impairments (Green et al., 2009). This could potentially affect the participants' performance in the proposed study, as they could struggle to complete the various athletic tasks. Children with ASD have lower resting heart rates than the general population (Pace & Bricout, 2015). The physiological stress response in these children is impaired, which means that autonomic responses to stress, physical, mental and social, occurs more infrequently than the typical population (Pace & Bricout, 2015). Chronic anxiety experienced by those with ASD could lead to a down regulation of the autonomic nervous system (Pace & Bricout, 2015). It is important to understand this lower heart rate response when taking measurements during exercise. Additionally, a lower heart rate response in children with ASD should indicate the importance of utilizing heart rate measures on these individuals during exercise.

Statement of the Problem

Based on the literature, children with ASD need to exercise as they are more prone to developing childhood obesity and engaging in screen time activities than typically developed peers. Antecedent exercise has been shown to be an effective way to decrease competing behaviors in children with ASD. However, intensity of the exercise session, in order to determine if the child is exercising or not, needs to be addressed in order to corroborate these findings.

Heart rate must be measured in order to ensure intensity of exercise. Sport has been shown to be important in assisting children with a wide range of disabilities in increasing positive social behaviors. Children with ASD have the capacity to learn some athletic skills such as swimming, but they have not been shown to be able to acquire basketball skills.

Statement of the Purpose

The purpose of the study was to determine if antecedent bouts of exercise are beneficial to children aged 8 to 11 with ASD to decrease competing behaviors and to observe if basketball skills could be acquired through the course of the study. Heart rate was measured to corroborate whether or not the participant with ASD was exercising to show if antecedent exercise was a valid intervention to use in decreasing competing behaviors.

Research Questions

1. What are the effects of an exercise program (basketball practice), corroborated by heart rate, on competing behaviors (e.g., stereotypy, disruptive behaviors)?
2. Can children with autism spectrum disorder acquire basketball skills through the use of direct instruction and physical prompting?

Method

Participants

Participants were recruited through Nebo School District in Utah. The special education director of Nebo School District provided recruitment fliers to the parents of children with ASD within the summer practicum program. The special education director nominated 5-6 children who met the criteria below. Parents were sent consent letters and when the parents of five students consented they were enrolled in the study.

Participants included five white non-Hispanic elementary-age students, three male and two female, with autism spectrum disorder (ASD) aged 8 to 11. One participant had an additional diagnosis of fetal alcohol syndrome. The students were currently attending special education classes and had current individualized education programs (IEP). The participants were selected because they met the initial criteria (e.g., ASD, age, IEP), were able to understand verbal prompting per teacher report, and were able to engage in moderate to vigorous physical activity. School records were used to evaluate evidence of educational classification, current assessment information, and ASD was listed as the students' qualification for special education on their IEP snapshot that was provided by the school district.

Participants included: Rachel, Adrienne, Bobby, Cody, and Alex. Four of the participants had a singular diagnosis of ASD, and one of the participants had a diagnosis of ASD and fetal alcohol syndrome. There were two second graders, two third graders, and one fifth grader. All of the participants were white, non-Hispanic living in Utah County.

All of the teachers in the study were practicum students in a summer school setting from Brigham Young University. Each practicum student had a mentor licensed teacher from Nebo School District that monitored all of the teaching that occurred during the course of the study.

Setting

The study was conducted during six weeks of a summer practicum extended school year. The study was conducted in the gym of Canyon Elementary School in Spanish Fork, Utah so there was access to the reduced-height, which was approximately 8 feet high, basketball standards. The behavioral data were taken in the classroom. There were two different types of classrooms found in the study. The first was classified as a setting for students with mild/moderate disabilities. There were approximately 5 to 7 students in a group receiving

instruction from a student teacher. In total, there were approximately 20 students in the classroom. Two of our participants were being taught in this setting. The second setting was classified as a setting for students with severe disabilities. There were approximately 1 to 2 students in a group receiving instruction from a student teacher. There were a total of 6 to 8 students in this classroom. Three of the participants in the study were taught in this study. In both settings there was a licensed mentor teacher who helped oversee the day-to-day operations of the classroom and three student teachers. Each student was taught by at least two of the three student teachers.

Measures

Disruptive and stereotypic behaviors. Disruptive and stereotypic behaviors were recorded for 10 minutes before and 10 minutes after antecedent exercise. Disruptive behaviors include talking without permission, arguing, name calling, or throwing materials (Kamps et al., 2011). Stereotypic behaviors are defined as repetitive nonfunctional behaviors such as hand or arm flapping, rhythmic rocking, repetitive jumping, floor pacing, object spinning, hand staring, eye rolling or crossing, toe walking, and vocalizations (Levinson & Reid, 1992). On-task was defined as engaging in any activity assigned by the teacher including assignments, looking at materials or teacher, the child orienting their body toward the teacher, asking or answering questions, writing or reading (Kamps et al., 2011). The child cannot participate in both disruptive or stereotypic behaviors and on-task behaviors at the same time. Partial interval recording was used to measure the disruptive behaviors that occurred in class. The observer recorded whether the behavior occurred at any time during the interval. If the behavior occurred more than once during a particular interval it was still scored as occurring just once during the interval (Cooper,

Heron, & Heward, 2007). Disruptive and stereotypic behavior was measured every 10 seconds for 10 minutes.

Skill acquisition. During the intervention the research assistants evaluated the participants' skill acquisition in the following areas: triple threat or ready position, dribbling while stationary, dribbling while walking, dribbling while jogging, shooting, and defensive slides. After a prompt of "show me" and the skill, the research assistant would evaluate if the child completed the different components identified in the task analysis. The skills were assessed at the beginning and end of each session the child engaged in.

Heart rate. At baseline, and after each component of the exercise intervention, research assistants used a refurbished Apple Watch Series 1 to measure the heart rate of each child. The Apple Watch has been shown to be a valid instrument to use to measure heart rate (Wallen, Gomersall, Keating, Wisløff, & Coombes, 2016; Wang et al., 2017). Research assistants observed the heart rate measure from the Apple Watch and wrote it down onto the skill acquisition data sheets. The heart rate was written down every 10 seconds for 60 seconds.

Observer training. Live training was done with research assistants with a prepared role play of how a child might engage in disruptive, stereotypic, and on-task behaviors. An additional live training was done with research assistants by demonstrating various basketball skills, and how they were to be taught to evaluate skill acquisition, and intervention fidelity. The task analyses were used to train observers on the fidelity of the intervention. When observers reached 80% accuracy within a live setting for both behavior monitoring, skill acquisition, and treatment fidelity they were considered competent to score the participants of the study.

Treatment fidelity. A checklist was created with seven items that was completed after several basketball sessions by the outside observers. The checklist was based on the steps of the intervention. Treatment fidelity was calculated on 30% of sessions, at an average of 95% fidelity.

Interobserver agreement (IOA). Interobserver agreement was calculated on classroom behaviors for a total of 20% of all sessions across all participants, skills, and phases. Sessions that did not reach 80% agreement were not included in this study. If agreement fell below 80% for two sessions, observers were kept to 90% accuracy with a second observer. Interobserver agreement on all data reached above 80% on average and never fell below.

Procedures

The purpose of the study was to implement an antecedent exercise program that would increase heart rate from normal resting levels in a population of children with ASD and note the changes on competing behaviors following those exercise bouts. The antecedent exercise program consisted of a basketball intervention. Implementation of the basketball intervention was done by Erika Richards. Erika Richards holds a master's degree in exercise science and is a certified coach and received a Coaching Minor from Fort Lewis College in 2014. Richards also played NCAA Division II women's basketball at Fort Lewis College from 2010-2014. While playing basketball at Fort Lewis College she also assisted in coaching a summer basketball camp for girls aged 5 to 17. Additional researchers or research assistants for the intervention had a background in applied behavior analysis and were taught the various basketball skills beforehand by Erika Richards.

Baseline. To obtain a measure of performance prior to the interventions, baseline data was taken for a minimum three days for the first participant until data were stable. Baseline data was taken for a minimum of five days for the second participant. The third participant remained

at baseline until the end of baseline for the second participant. The third participant had baseline data taken for a minimum of seven days. Baseline data were taken on disruptive classroom behaviors, stereotypy, on-task behavior, and heart rate. Heart rate was measured at rest, no movement, while the child is standing to obtain an accurate baseline. Baseline data for the classroom was measured for 10-minutes prior to and 10-minutes following the baseline intervention. Classroom procedures were business as usual, but conducted under academic instructional time. Baseline conditions were held constant throughout the study.

Intervention phases. The participants were monitored in the classroom for 10 minutes prior to the intervention through the use of two observers. The observers were positioned at the back of the classroom. This positioning gave the correct vantage point in order to monitor all of the participants' behaviors as they moved about the classroom. The observers measured disruptive, stereotypic, off-task and on-task behaviors.

The basketball intervention occurred four times a week for six weeks. A direct instruction methodology was implemented to deliver basketball instruction including modeling, guided practice, and independent practice. Direct instruction has been shown to be an effective way to teach skills to children with ASD (Ganz & Flores, 2009). Similar to the study done by Reid, Collier, and Cauchon (1991), physical prompting was used to help shape skills. The intervention began with putting on the Apple watch or Fitbit to measure the child's resting heart rate. This was followed by a 5-minute warm-up where the child was asked to jog back and forth across the gym. During the first intervention session, the child was asked to complete the skills without instruction to gage the child's level of basketball skill. The prompt "show me (skill)" was given to the child to request the performance of each basketball skill. Heart rate was measured after each skill. The child was then instructed on the triple-threat or ready position for 5 minutes.

Heart rate was measured. The child was taught the basketball skills in the following order: ready position, dribbling (stationary), dribbling (while walking), defensive slides, and, finally, shooting. Baseline data were taken for each skill. The skill was taught until the child could complete the skill without any additional prompting following the verbal cue "show me (skill)." Once the skill was mastered, or completed each step of the skill without prompting, the child was then taught the next skill. Mastery was corroborated by data taken by the observers, as well as the interventionist's understanding of basketball. After the instructional component of the session, the child was allowed to complete the other skills without instruction. Heart rate was measured after each component of the intervention (warm-up, ready position, dribbling, defensive slides, end of session). Each of the participants was instructed individually in the various skills, though at times there were multiple participants in the gym at the same time. If the participant was not receiving the instruction, a research assistant engaged in the basketball skills with them on a different basketball standard. The total duration of the basketball intervention was approximately 45 minutes.

After each skill was mastered, all the following sessions went as follows: The intervention began with the child putting on the Apple Watch and monitoring resting heart rate followed a 5-minute warm-up began to jog around the gym. Heart rate was measured after each section of the basketball intervention. Following the warm-up, the child was asked to perform the basketball skill, to show retention, with the prompt, "show me (skill)." The child participated in 5 minutes of dribbling, going back and forth down the length of the basketball court. The child was instructed to go down the court dribbling as fast as they felt able with their dominant hand. If the child felt comfortable, they were instructed to return the length of the court with their non-dominant hand. The child was permitted to use their dominant hand both ways if they felt

uncomfortable using their non-dominant hand. After dribbling, the child did defensive slides down the length of the court for 5 minutes. Next, a shooting session for 10 minutes was done. During the shooting session the child would shoot at five different spots around the basket: baseline, first hash-mark on the key, middle of the key, opposite first hash-mark, and opposite baseline. The shooting station was the longest as the children found it the most fun and time was spent rebounding the basketball if it bounced far away. Finally, the child was then asked to perform the skills again to see if skill level improved post-session. The exercise intervention lasted a total of 40-45 minutes, after which the participants returned to their classroom and rejoined in classwork that their classmates were doing in their absence.

After the intervention, in the classroom, the participants were observed for 10 minutes. The observers were positioned at the back of the classroom so as to monitor all the child was doing and without disrupting the teacher and students.

Research Design

This study followed a single-participant, multiple-baseline design across participants (Baer, Wolf, & Risley, 1968; Nicholson et al., 2011). Baseline data were taken for a minimum three days for the first participant until data were stable. Baseline data were taken for a minimum of five days for the second participant. The third participant remained at baseline until the end of baseline for the second participant. The third participant had baseline data taken for a minimum of seven days. The intervention phase lasted four weeks. Post-intervention data were taken for one week.

Data Analysis

This study used visual analysis methods to evaluate the effects of the intervention. Visual analysis was conducted by evaluating the level, trend, and variability within each phase. Baseline

and intervention phases were analyzed between phases on immediacy of the changes and consistency across participants and skills. In addition to visual analysis, standard mean difference (SMD) effect size was calculated for each measure to evaluate the magnitude of the change. The method for calculating SMD was: Intervention Mean – Baseline Mean / √ Baseline Standard Deviation.

Results

Behavior effects are described below. On-task behavior data can be found in Table 1, disruptive behavior can be found in Table 2, and repetitive behavior can be found in Table 3. The tables include means, and standard variations for the behaviors at both baseline and during the intervention, and effect sizes between behaviors before practice and after practice are reported. Heart rate data can be found in Table 4, and this table shows mean heart rate data for resting heart rate levels as well as each phase of the intervention.

Behavioral Effects

On-task behavior. On-task behavior in the classroom was relatively high across all participants in the study. Rachel showed little change from baseline data collection through the course of the intervention (Figure 1). Behavior remained highly variable before and after the basketball practice and at baseline and intervention. Cody showed a noticeable downward trend in on-task behavior at baseline for his before and after basketball (Figure 2). When the intervention was implemented, Cody's data showed an increase in level before and after basketball practice. Adrienne's on-task behavior was highly variable before and after exercise time during baseline (before range = 0-100; after range = 0-100). The intervention phase did not impact on-task behavior for Adrienne, as the level, trend, and variability remained mostly similar to the baseline's level, trend, and variability (Figure 3). Bobby's before- and after-basketball data

did not show significant changes in level and trend during baseline or intervention (Figure 4). However, the before basketball data showed a noticeable reduction in variability from baseline to intervention with the before measure. Alex's on-task behavior remained high during both phases and before- and after- basketball practice (Figure 5). Some variability was noted, but the behavior was largely unaffected by the basketball practice intervention (Table 1).

<Insert Table 1 here>

Disruptive behavior. During baseline, Rachel's disruptive behavior had an increasing trend both before and after the basketball practice (Figure 1). During the intervention phase the initial before session was similar to baseline, but the behavior quickly reduced to near-zero levels. Cody's baseline showed at increasing trend before and after the basketball practice (Figure 2). Following the intervention, his disruptive behavior quickly reduced to zero and near-zero levels. Adrienne's baseline showed a mixed result (Figure 3). Before basketball time her data varied, but were generally stable. She was very disruptive on one day after the basketball time, but during baseline, her after sessions disruptive behaviors quickly decreased to zero levels. Following the implementation of the intervention, her before-basketball data remained at zero levels, and her after-basketball data was variable in the beginning but toward the end of the phase was a zero or near-zero levels. Bobby's disruptive behavior was generally infrequent during baseline (Figure 4). Following the implementation of the intervention, his disruptive reduced to zero levels for the before-basketball observations and in only one session after basketball did Bobby exhibit disruptive behavior. Alex's baseline for disruptive behaviors was similar before and after basketball practice (Figure 5). Although it was low, the behavior was also variable. When the intervention was implemented, the before-practice time period showed a

similar pattern to baseline, but the observations after basketball were at zero levels for four out of five sessions (Table 2).

<Insert Table 2 here>

Repetitive behavior. Repetitive behaviors were mostly unaffected by the intervention (Figure 1-5). Rachel's data was highly variable and never showed experimental control. Cody's repetitive behaviors showed an increase following the intervention. Adrienne's repetitive behaviors were variable and did not show experimental control. Like Cody, Bobby's repetitive behaviors showed a noticeable increase following the implementation of the intervention. Alex's repetitive behaviors showed similar levels as baseline (Table 3).

<Insert Table 3 here>

<Insert Figures 1-5 here>

Heart Rate

Level of exercise was evaluated based on the ACSM definition of moderate to vigorous exercise for children which was 120 to 176 BPM (Medicine, 2013). Rachel engaged in moderate to vigorous levels of exercise post-run, post-skill check, post-skill teaching, and upon completion of the intervention. Rachel's resting heart rate at both baseline and during the intervention was approximately 101 BPM. Cody engaged in moderate to vigorous levels of exercise-post-run, post skill check, post teaching, and upon completion of the intervention. Cody's resting heart rate was 94.6 BPM during baseline, and 93.3 BPM during the intervention. Adrienne also engaged in moderate to vigorous exercise after each phase of the intervention. Adrienne's resting heart rate during baseline was 87.5 BPM and 86.9 BPM during the intervention. Average heart rate for typically developed females her same age is between 96 BPM and 101 BPM. Adrienne was approximately 10-15 BPM lower than average. Bobby engaged in moderate to vigorous exercise

after the teaching phase of the intervention, and was near moderate levels of exercise in both the post run and post skill check phases at 118 and 119.4 BPM, respectively. Bobby's resting heart rate was 99.4 BPM at baseline and 89.4 BPM during the intervention. Alex, based on his heart rate, was never engaging in moderate to vigorous exercise during the study. Alex also had a significantly lower resting heart rate. Resting heart rate for typically developed males ranges between 95 and 106 BPM, and Alex had a resting heart rate of 87.1 BPM at baseline and 72.7 BPM during the intervention, which is approximately 20 BPM lower than average (Table 4).

<Insert Table 4 here>

Skill Acquisition

Participant 1. At baseline, Rachel had an average of 19% of the total skills mastered and a decreasing trend. During the intervention, Rachel was able to master 81% of the total skills with an increasing trend and low variability. The most difficult skill was shooting the basketball, as it required mastery of the most steps (8 steps), and Rachel was able to reach 82% of mastery. Her highest skill was the triple-threat or ready position at 99% mastery. Her lowest skill was defensive slides at 60% mastery. Based on visual analysis of the data, Rachel was able to increase her overall basketball skill level from baseline to intervention and maintain it throughout the course of the study (Figure 6).

Participant 2. At baseline, Cody had an average percentage of 18% total skill mastery and was relatively stable. During the intervention, Cody increased his total skill mastery to 59% with an increasing trend and some variability. Cody's average highest skill was triple-threat or ready position at 77%, and his lowest skill was defensive slides at 28% mastery, both at the intervention stage (Figure 6).

Participant 3. At baseline, Adrienne had an average of 30% skill mastery with a decreasing trend and some variability. During the intervention, Adrienne had an average of 92% skill mastery with an increasing trend and low variability. Near the end of the intervention her skill level was relatively stable nearing the 100% skill mastery level. Adrienne's highest percentage of skill mastery was shooting at 96% mastery. Her lowest skill at the end of the intervention phase was defensive slides at 86% mastery (Figure 6).

Participant 4. At baseline, Bobby had an average of 28% skill mastery with an initial decreasing trend and a slight increasing trend with some variability. During the intervention, Bobby had an average of 77% skill mastery with an increasing trend with the data being variable. Bobby's highest skill during the intervention was dribbling in one place at 96% skill mastery. Bobby's lowest skill was shooting at 75% skill mastery (Figure 6).

Participant 5. At baseline, Alex had an average skill mastery of 7% across all skills with a slight decreasing trend, low variability, leveling out close to 0% skill mastery. During the intervention, Alex had an average 40% skill mastery with an increasing trend, some variability. Alex's highest skill during the intervention was triple threat or ready position at 60% skill mastery. His lowest skill during the intervention was defensive slides at 30% skill mastery. Shooting was also low at 31% skill mastery (Figure 6).

<Insert Figure 6 here>

Discussion

The first research question of the study was, "What are the effects of an exercise program (basketball practice) on competing behaviors (e.g., stereotypy, disruptive behaviors)?" It was hypothesized that an antecedent exercise, or basketball practice, intervention would reduce competing behaviors such as disruptive or stereotypic behaviors in children with ASD. Other

authors found that exercise caused decreases in self-stimulatory behaviors and disruptive behaviors as well as increasing on-task behavior (Bahrami et al., 2012; Oriel et al., 2011; Prupas & Reid, 2001). This hypothesis was not completely supported by the data. The intervention impacted the behavior of each child in different ways. On-task behavior was not really affected by the antecedent exercise intervention. This could be due to the fact that the participants showed relatively high levels of on-task behavior throughout the course of the study. Additionally, each of the participants were in a smaller class with a higher adult-to-teacher ratio than during a typical school year, which meant that the teachers could have been able to maintain a higher level of redirection, making on-task behavior relatively consistent throughout the study. Disruptive behavior decreased throughout the course of the intervention for each of the participants. While at times disruptive behavior was noted in the before practice observation during the intervention, it reduced to zero levels or near-zero levels after the basketball practice. This could be due to fatigue following antecedent exercise. Based on the heart rate data taken during the intervention, four of the five participants were participating in moderate to vigorous physical activity for approximately 45 minutes, which is 75% of their daily physical activity recommendation (60 minutes). Heart rate corroboration of exercise differed from the use of flushed face and increased breathing to determine exercise, which adds to antecedent exercise research (Losinski et al., 2017; Neely et al., 2015; Prupas & Reid, 2001). The four participants who showed increases in heart rate could indicate that moderate-to-vigorous antecedent exercise helps reduce disruptive behaviors. Repetitive or stereotypic behaviors were not affected by antecedent exercise and for two of the five participants, stereotypic behavior increased following the intervention. The repetitive behaviors noticed after basketball practice, however, included a lot of sweat wiping and face rubbing. Though wiping sweat away following an exercise bout

could be seen as functional, the children engaged in this behavior repetitively and compulsively. This could be a result of the warm summer temperatures causing increased perspiration, as well as increased physiological response to exercise as their heart rates increased.

The study cannot corroborate the findings of previous studies stating that antecedent exercise reduces stereotypic and disruptive behaviors. A majority of the studies in the literature suggest that children with ASD decrease in stereotypic and disruptive behaviors following antecedent exercise, however, without using measurable objective physiological responses, exercise might not have occurred (Bremer et al., 2016; Lang et al., 2010; Prupas & Reid, 2001). Although in a study done by Losinski, Cook, Hirsch, and Sanders (2017) had the participants going up to 50% of their heart rate max, in the current study, the participants were reaching 65-70% or more of their heart rate max. Physiologically, the students were exercising, which included increased heart rate which could cause sweating, and sweat wiping was one of the observed stereotypic behaviors following exercise. While disruptive behaviors decreased following a 45-minute bout of antecedent exercise, this could be a result of fatigue rather than a direct result from the intervention itself. Additionally, stereotypic behaviors were not shown to be impacted by the antecedent exercise.

The second research question proposed in the study was: “Can children with autism spectrum disorder acquire basketball skills through the use of direct instruction and physical prompting?” It was hypothesized that children with ASD would be able to acquire some level of basketball skills throughout the course of the study. This hypothesis was supported through the findings of the current study. Each child increased mastery in each basketball skill through the use of direct instruction through modeling, guided practice, and independent practice. Additionally, physical prompting and shaping was used to direct the students where to correctly

place their hands on the ball to perform triple threat or ready position, dribbling, and shooting during the teaching portion of the intervention. Acquisition of the skills, however, was measured without prompting, showing that the participants were able to maintain the skills they learned during the instructional period.

These results support what was found in other studies on athletic skill acquisition in children with autism spectrum disorder. Children with ASD were able to acquire athletic skill with the help of direct instruction similar to what was said by Prupas et al. (2006). Reid, Collier, and Cauchon (1991), showed that children with ASD were able to acquire athletic skills through the use of physical prompting. Children with ASD acquired target skills of the sport of basketball, similar to what was shown with other studies where the participants acquired the most important skills in several studies involving swimming (Chu & Pan, 2012; Yilmaz, Konukman, Birkan, & Yanardağ, 2010). This type of mastery of sport skills has been suggested in the research to increase their future interactions with typical peers (Miltenberger & Charlop, 2014).

Limitations

The study had some limitations. Each of the students had a different teacher, a practicum student, during the summer practicum program, and received behavioral interventions for each of the competing behaviors. Differing behavior interventions could have mixed effectiveness in reducing competing behaviors. Additionally, the teachers were practicum students from Brigham Young University that had not graduated from their teacher preparation programs yet. This was their first opportunity to give lessons, utilize classroom management skills, and implement behavior interventions. Their lack of experience could impact the behaviors of the participants of the study. We had not observed the students long enough to know what their consistent repetitive

behaviors were. There could have been subtle repetitive behaviors that could have been observed during baseline and impacted the results of the study. Knowing the participants better could have changed the behavioral observations. Another limitation to the current study was that the participants were taught team sport skills on a one-on-one manner. Had there been group instruction, there could have been greater social implications.

Implications for Future Research

Future research can be done to see if other forms of antecedent exercise, corroborated by heart rate data, are able to show decreases in both stereotypic and disruptive behaviors in children with ASD. Other sports, including both team sports and individual sports, can be taught to individuals with ASD to see if they are able to master the motor skills necessary to compete in other events besides basketball. Studies can be done to note the social implications of teaching sports, specifically but not limited to team sports, as a form of antecedent exercise in populations with ASD.

Implications for Practitioners

Children with ASD were shown to have some reductions in disruptive behavior due to antecedent exercise. If a child with ASD is noted to be particularly disruptive it might be worthwhile to allow the child to engage in some form of moderate to vigorous physical activity prior to an academic class. Additionally, parents can try to put their children with ASD into after-school sports programs.

Social Validity

The participants in the study were willing to participate in the basketball intervention. The participants vocally expressed (in their classroom settings) that their favorite portion of the summer practicum was engaging in the basketball intervention. Other students in summer

practicum who were not in the study frequently asked the researchers if they could come and participate. The participants in the study also mentioned that as they learned the basketball skills that the sport became easier. Three of the participants also seemed to gain enough consistent basketball skills to be able to join a basketball team in the community. The special education director of Nebo School District relayed this to the parents of these three participants.

Conclusion

The study tried to determine if antecedent exercise reduced competing behaviors in the classroom setting. Through the course of the intervention, disruptive behaviors in the classroom were reduced immediately following antecedent exercise (the basketball practice). This could be due to increased fatigue in the participants after engaging in moderate-to-vigorous exercise. Stereotypic behaviors were not affected by the antecedent exercise intervention. The participants of the study engaged in sweat wiping and face rubbing following the intervention, which, by definition of its repetition, was coded as stereotypic. Four of the five participants were shown to engage in moderate-to-vigorous exercise based on their mean exercise heart rates through the various stages of the study. Throughout the different components of the intervention these four participants' heart rate was around or above 120 BPM, which is considered to be a moderate level of exercise. The study also provided information of the effects of teaching exercise skills, specifically basketball skills, to children with autism spectrum disorder. Each one of the five children in the study increased in their skill mastery level of each basketball skill that was taught with direct instruction and some physical prompting. These findings suggest that children with autism spectrum disorder have the ability to acquire enough motor skills in order join sports programs and participate in athletics along with typically developing peers. Previous research has shown that children with ASD benefit socially from participation in sports, and are able to

learn athletic skills better when peers help teach them. Involvement in exercise also has positive health effects in children with ASD who have been shown to have an increased likelihood of developing health issues.

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Tables

Table 1

On-Task Behavior

		Baseline		Intervention		
		Mean	*SD*	Mean	*SD*	ES
Rachel	Before Practice	79.0	*16.5*	69.9	*25.8*	2.24
	After Practice	79.0	*20.9*	80.1	*17.3*	0.23*
Cody	Before Practice	79.6	*12.9*	86.9	*9.7*	2.04***
	After Practice	71.1	*18.3*	88.7	*9.4*	4.12***
Adrienne	Before Practice	77.3	*32.5*	83.6	*25.0*	1.11***
	After Practice	64.3	*36.0*	75.9	*28.3*	1.93***
Bobby	Before Practice	82.6	*18.1*	98.1	*0.9*	3.64***
	After Practice	87.1	*11.1*	90.3	*7.4*	0.95***
Alex	Before Practice	80.2	*7.3*	76.2	*4.7*	-1.49
	After Practice	77.8	*23.2*	79.9	*10.3*	0.42*

* = small effect, **=medium effect, ***=large effect

Table 2

Disruptive Behavior

		Baseline		Intervention		
		Mean	*SD*	Mean	*SD*	ES
Rachel	Before Practice	10.9	*14.6*	5.6	*10.6*	1.39***
	After Practice	17.9	*22.6*	4.7	*4.3*	2.79***
Cody	Before Practice	15.5	*14.7*	0.4	*0.8*	3.92***
	After Practice	15.4	*17.9*	3.9	*6.3*	2.72***
Adrienne	Before Practice	9.5	*8.2*	0.0	*0.0*	3.32***
	After Practice	24.0	*36.3*	8.6	*15.5*	2.56***
Bobby	Before Practice	8.4	*15.5*	0.0	*0.0*	2.13***
	After Practice	6.3	*8.7*	0.4	*1.1*	1.98***
Alex	Before Practice	6.1	*7.6*	4.8	*5.2*	0.47*
	After Practice	5.2	*6.1*	0.6	*1.3*	1.86***

* = small effect, **=medium effect, ***=large effect

Table 3

Repetitive Behavior

		Baseline		Intervention		
		Mean	*SD*	Mean	*SD*	ES
Rachel	Before Practice	23.2	*18.9*	17.2	*24.1*	1.38***
	After Practice	15.6	*12.2*	10.7	*9.3*	1.39***
Cody	Before Practice	0.9	*1.8*	5.2	*6.4*	3.23
	After Practice	7.0	*9.9*	10.9	*10.8*	1.21
Adrienne	Before Practice	8.9	*11.0*	4.6	*7.3*	1.30***
	After Practice	4.4	*5.3*	1.4	*2.4*	1.29***
Bobby	Before Practice	8.7	*10.4*	43.1	*14.6*	10.71
	After Practice	7.0	*9.0*	27.3	*19.6*	6.79
Alex	Before Practice	13.3	*9.0*	6.5	*7.1*	2.24***
	After Practice	30.3	*15.2*	31.0	*9.6*	0.17

* = small effect, **=medium effect, ***=large effect

Table 4

Heart Rate Data

	Baseline	Intervention				
Participant	Resting	Resting	Post Run	Post Skill Check	Post Teaching	Final
Rachel	101.5	101.4	153.3	120.3	153.0	137.1
Cody	94.6	93.3	129.3	122.1	128.2	130.9
Adrienne	87.5	86.9	141.3	122.6	129.0	144.0
Bobby	99.4	89.4	118.0	119.4	125.4	109.8
Alex	87.1	72.7	94.2	91.8	85.0	84.4

Figures

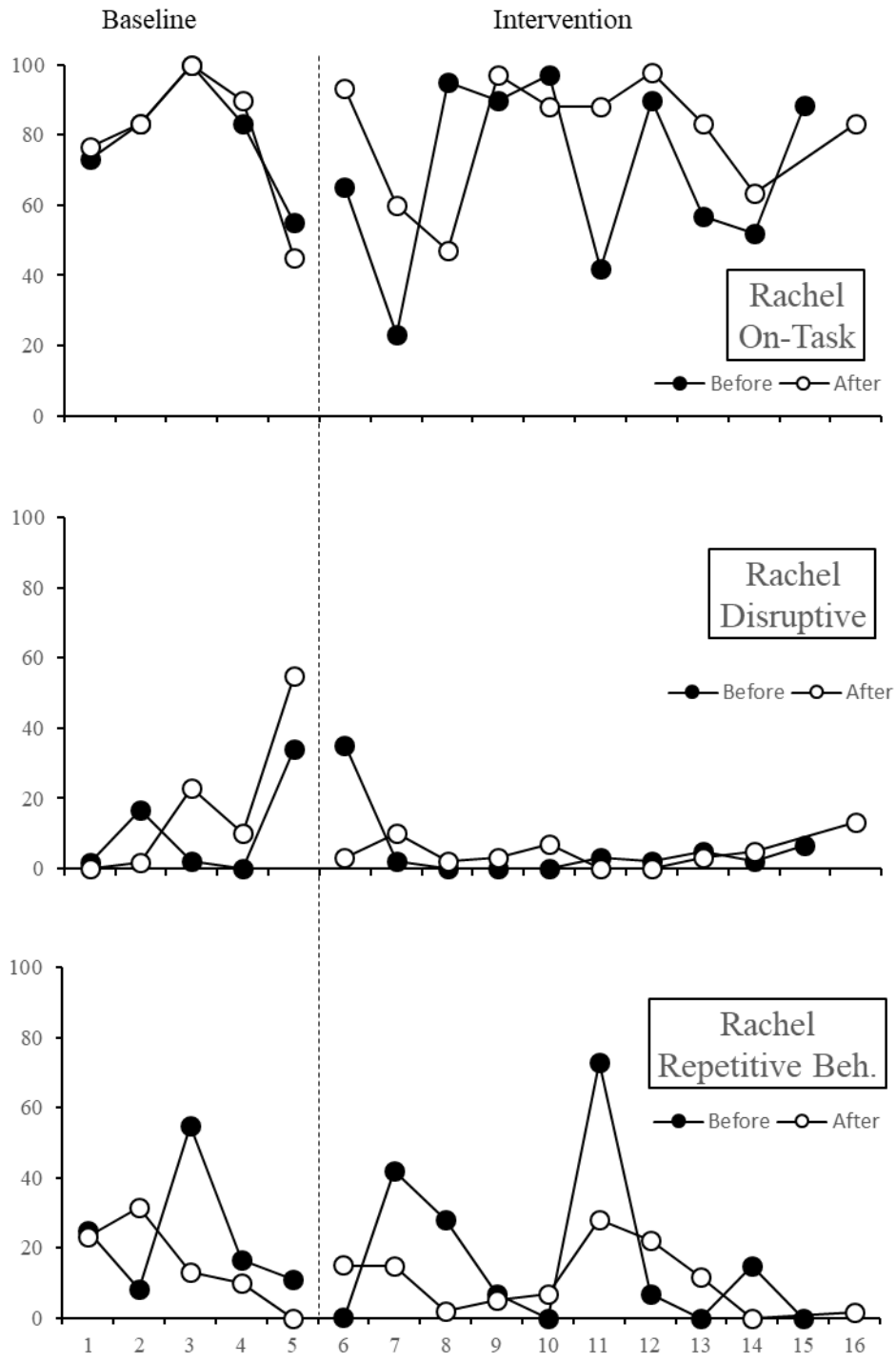

Figure 1. Rachel's on-task, disruptive, and repetitive behaviors.

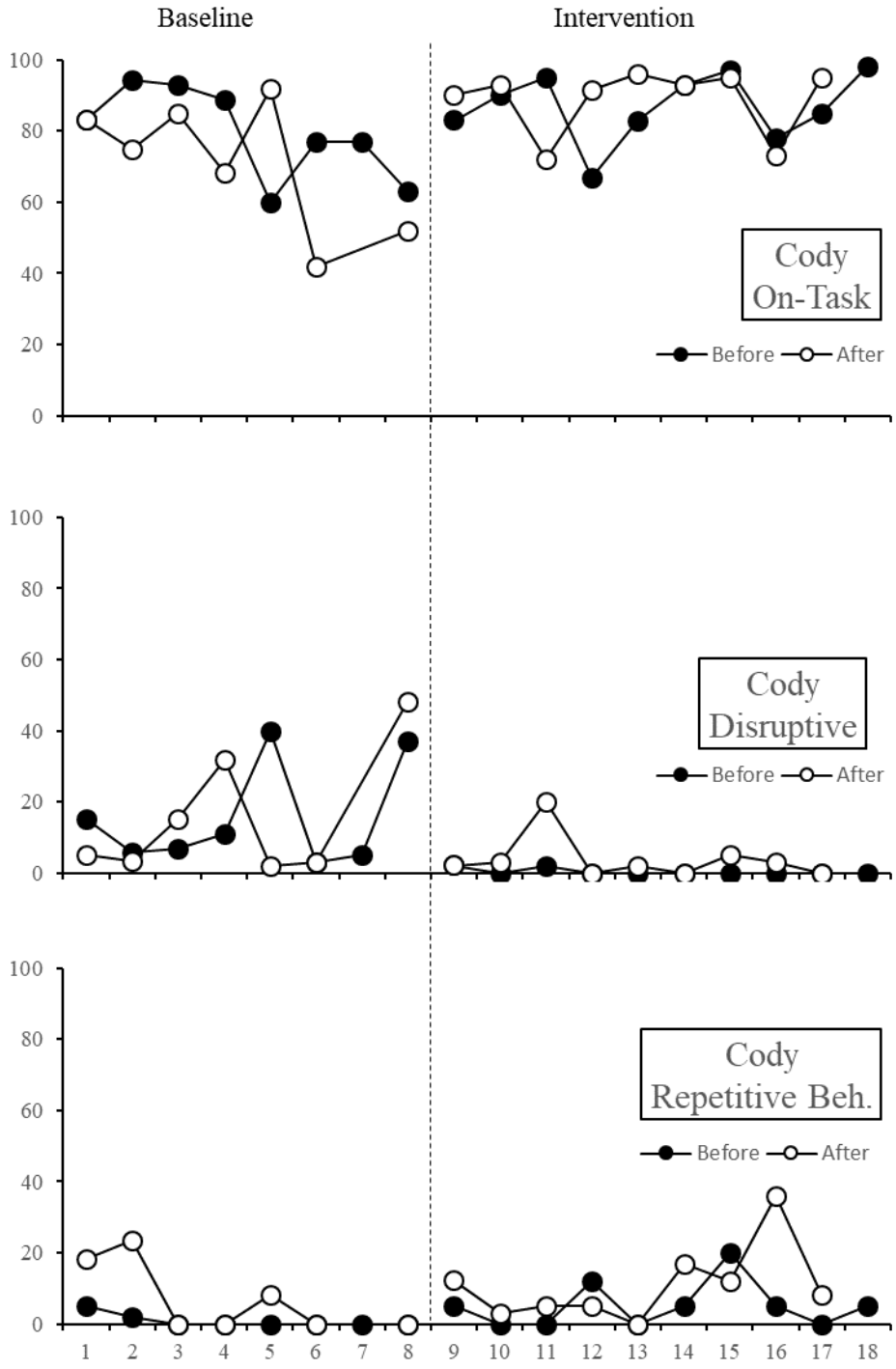

Figure 2. Cody's on-task, disruptive, and repetitive behaviors.

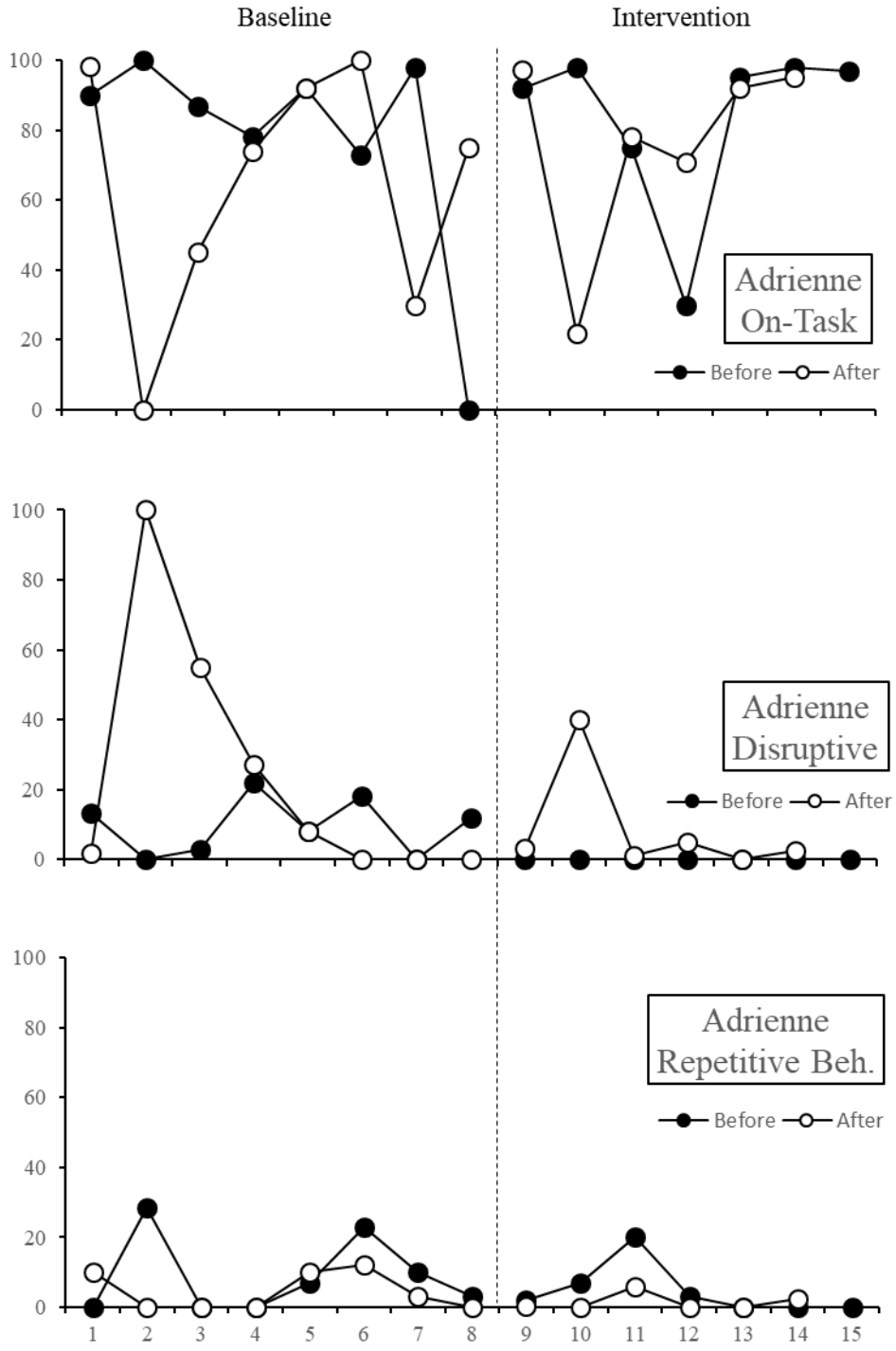

Figure 3. Adrienne's on-task, disruptive, and repetitive behaviors.

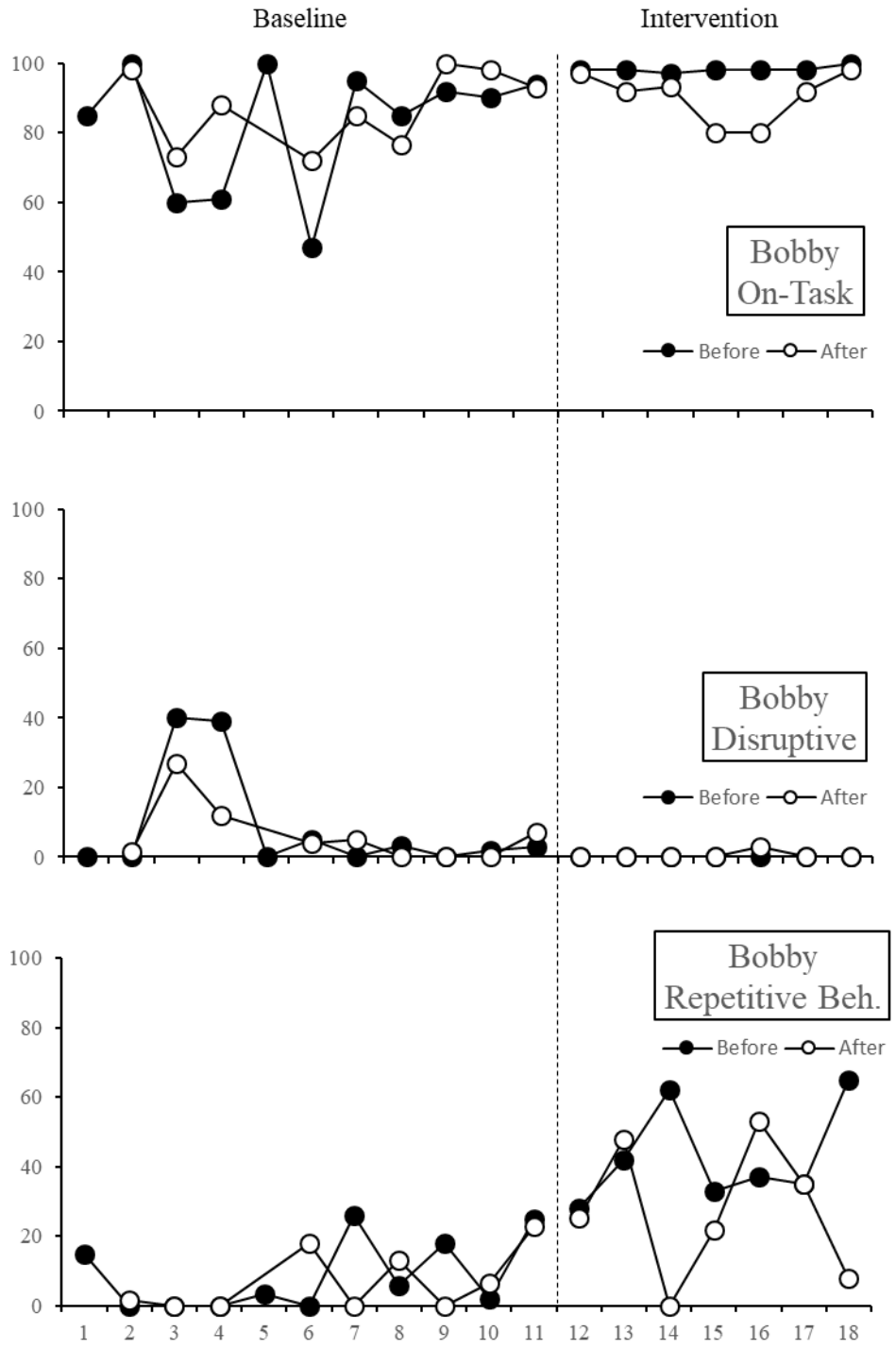

Figure 4. Bobby's on-task, disruptive, and repetitive behaviors.

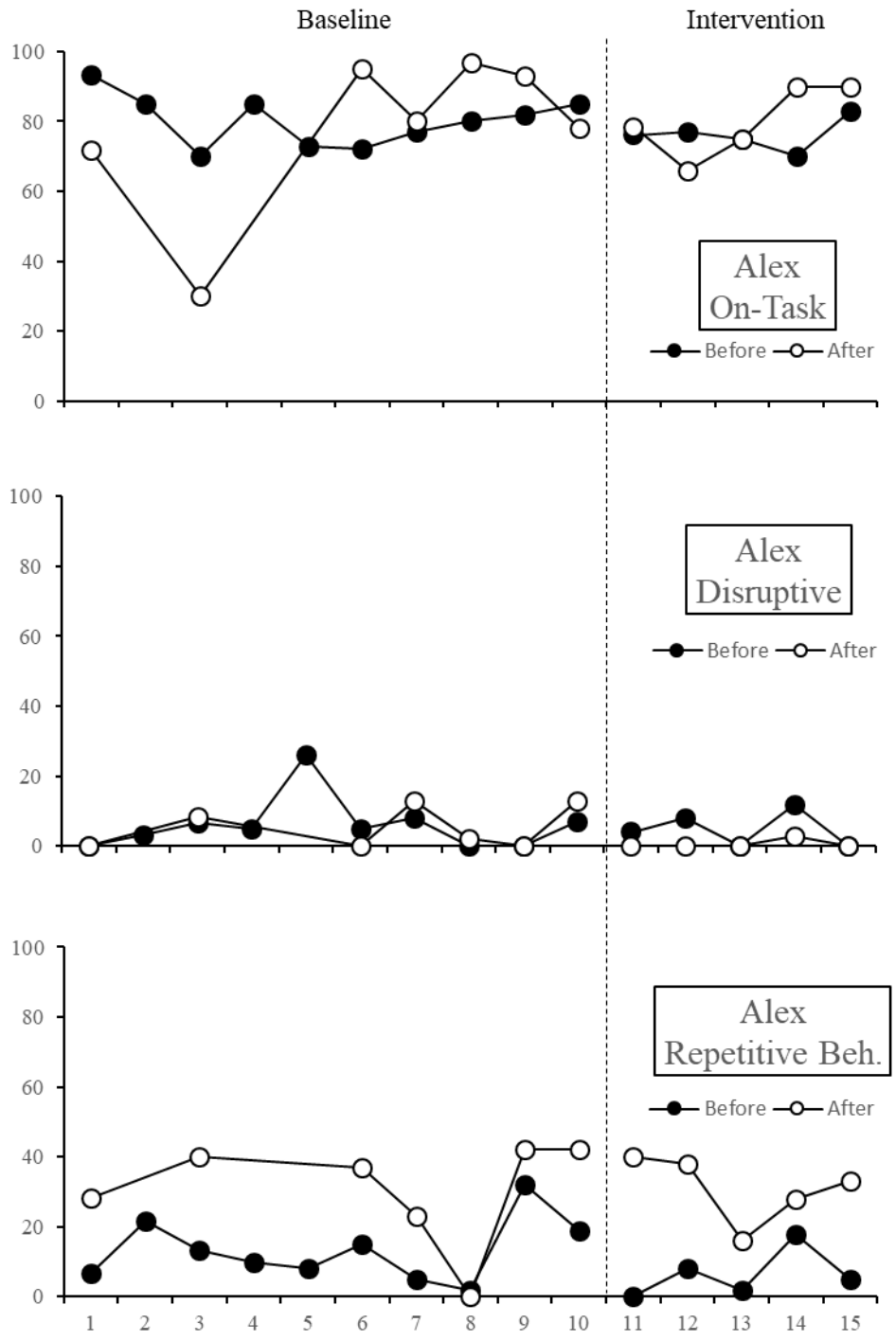

Figure 5. Alex's on-task, disruptive, and repetitive behaviors.

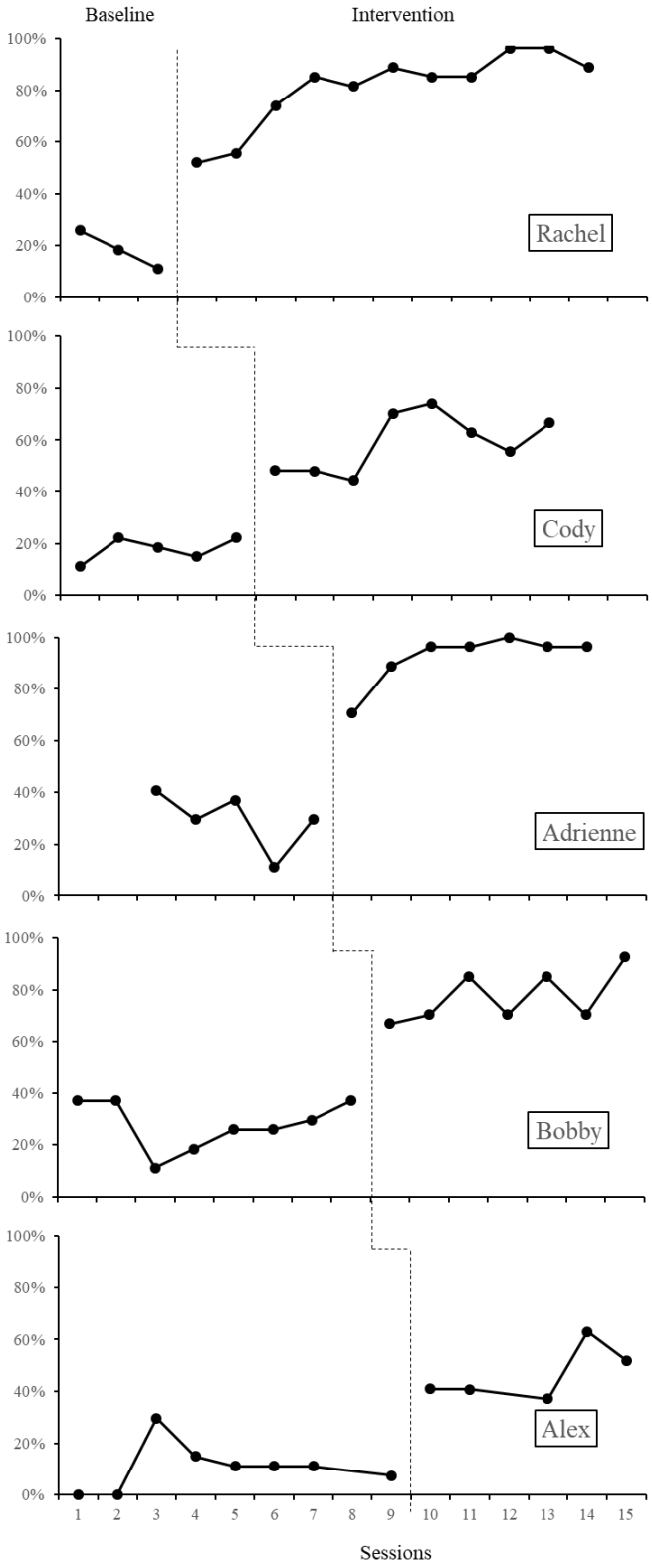

Figure 6. Participants skill acquisition graph.

APPENDIX A: Review of Literature

Introduction

Childhood obesity is the number one health concern among parents in the United States with over one-third of children being classified as either overweight or obese (Corvey et al., 2016; Kist et al., 2015; Tyler et al., 2014; Zuckerman et al., 2014). Childhood obesity can lead to patterns of unhealthy living that result in far reaching health problems such as: type 2 diabetes, cardiovascular disease, hypertension, dyslipidemia, orthopedic problems, sleep apnea, depression, and low self-esteem (Füssenich et al., 2016; Kist et al., 2015; Zuckerman et al., 2014). Physical activity is a key to weight reduction and a healthy lifestyle (Kist et al., 2015). Amount of physical activity is a predictor of cardiovascular disease related health problems and mortality (Füssenich et al., 2016). The World Health Organization suggests that children aged 5 to 17 accumulate 60 minutes of moderate-to-vigorous physical activity every day (Füssenich et al., 2016). Moderate –to-vigorous physical activity is defined as 64% of maximal heart rate to 94% of maximal heart rate efforts (Medicine, 2013). A study done by Fussenich et al. (2016) suggests that this still is not enough physical activity to decrease the risk of cardiovascular disease in children. An amount of nearly 90 minutes of moderate-to-vigorous activity is suggested for children to have healthier lives as they age (Füssenich et al., 2016). Only 70% of children aged 6 to 11 in the U.S. meet the minimum daily requirements for physical activity (Wilson, Haegele, & Zhu).

Exercise testing is an accepted way to determine cardiovascular health in children as well as adults (Washington et al., 1988). Through the use of exercise testing maximal heart rate and gas exchange values in children have been assessed to determine fitness level. Heart rate can be used to determine the amount of work that was done during an exercise bout. In 150 Caucasian

children aged 7 years 6 months to 12 years 9 month mean resting heart rates of 106 beats per minute (BPM) , 96 BPM, and 95 BPM for males, and 101 BPM, and 96 BPM in females were measured (Washington et al., 1988). Maximal heart rate values post exercise testing included 191 BPM, 194 BPM, and 193 BPM in males, and 196 BPM in females (Washington et al., 1988). Average recovery heart rates in males were 133 BPM, 138 BPM, and 148 BPM, and in females, recovery heart rates were 142 BPM, 155 BPM, 160 BPM. According to Washington et al. (1988) girls have higher heart rates than boys at maximum exercise. Based on the ACSM definition of moderate-to-vigorous exercise the children should exercise at rates ranging from 120 to 176 BPM (Medicine, 2013; Washington et al., 1988). It is imperative to implement moderate-to-vigorous exercise in the lives of children as it establishes a healthy lifestyle.

Autism Spectrum Disorder

Autism spectrum disorder (ASD) affects 16.8 per 1,000, or 1 in every 59 children, who are 8 years of age (Christensen et al., 2016). ASD affects more boys than girls (23.6 per 1,000 vs. 5.3 per 1,000) and more non-Hispanic whites than non-Hispanic blacks or Hispanic children at 15.5 per 1,000, 13.2 per 1,000, and 10.1 per 1,000 respectively (Christensen et al., 2016). The prevalence of ASD has been increasing dramatically, with a prevalence of 3.4 per 1,000 in 1996, 6.7 per 1,000 in 2000, and 9.0 per 1,000 in 2006 (Christensen et al., 2016). According to the DSM-V, autism spectrum disorder is diagnosed as the child has: “persistent deficits in social communication and social interaction across multiple contexts”, and “restricted, repetitive patterns of behavior, interests, or activities”, and when these symptoms present themselves early in development, and are not better explained by other intellectual disabilities (American Psychiatric Association. & American Psychiatric Association. DSM-5 Task Force., 2013).

Social-emotional deficits in children with autism spectrum disorder can manifest themselves in various ways. Social emotional reciprocity problems can vary from abnormal social approach and failure of normal back-and-forth conversation; to reduced sharing of interests, emotions or affect; to failure to initiate or respond to social interactions (American Psychiatric Association. & American Psychiatric Association. DSM-5 Task Force., 2013). Deficient nonverbal communication can include inability to properly integrate verbal and nonverbal communication, abnormalities in eye contact, body language, and understanding of gestures, and total lack of facial expressions and nonverbal communication (American Psychiatric Association. & American Psychiatric Association. DSM-5 Task Force., 2013). Those with autism spectrum disorder may also have problems with developing, maintaining, and understanding relationships, difficulties adjusting behavior to suit various social situations, difficulty with imaginative play, difficulty making friends, and absence of interest in peers (American Psychiatric Association. & American Psychiatric Association. DSM-5 Task Force., 2013).

Repetitive patterns of behaviors or interests are characteristic of those with autism spectrum disorder. Repetitive, or stereotyped, behaviors can show themselves in various ways. Stereotyped motor movements, use of objects, or speech (echolalia) could be observed in children in with ASD (American Psychiatric Association. & American Psychiatric Association. DSM-5 Task Force., 2013). Those with autism spectrum disorder can show rigidity in sameness, adherence to routines, or ritualized patterns of verbal and nonverbal behavior, and highly restricted, fixated interests that are abnormal in intensity (American Psychiatric Association. & American Psychiatric Association. DSM-5 Task Force., 2013). Persons with ASD might also experience hyper- or hyporeactivity to sensory input or unusual interest in sensory aspects of the

environment (American Psychiatric Association. & American Psychiatric Association. DSM-5 Task Force., 2013). If any of the social-emotional symptoms or restrictive, repetitive behaviors are present early in development, cause significant impairments in social, occupational, or other important areas of functioning, or are not better explained by other intellectual disabilities, a person would be diagnosed with autism spectrum disorder (American Psychiatric Association. & American Psychiatric Association. DSM-5 Task Force., 2013). Autism spectrum disorder might or might not be accompanied by intellectual impairments, language impairments, or be associated with another know medical or genetic condition or environmental factors (American Psychiatric Association. & American Psychiatric Association. DSM-5 Task Force., 2013)

Exercise Habits in those with Autism Spectrum Disorder

Children with ASD are at a particularly high risk of being overweight or obese and are more likely to engage in more sedentary behaviors (Corvey et al., 2016; Must et al., 2015; Tyler et al., 2014). Obesity is also suggested to be affecting children with ASD at a younger age and more severely (Zuckerman et al., 2014). Though ASD is not independently related to obesity, secondary conditions associated with ASD lead to the increased risk (Corvey et al., 2016). Many additional secondary factors associated with autism including severity of diagnosis, behavioral problems, social and physical barriers to physical activity, and use of behavioral medication may increase the likelihood of children with ASD to become overweight (Corvey et al., 2016; Must et al., 2015; Zuckerman et al., 2014).

Physical activity has many physical, emotional, psychological, and behavioral benefits. Research shows that aerobic moderate-to-vigorous exercise in children promotes executive function of the brain or effortful and goal-directed cognition and behavior, as well as increases physical fitness (Best, 2010; Tyler et al., 2014). Children with autism spectrum disorder are less

likely to engage in physical activity and tend to be less physically fit than typically developed peers (Tyler et al., 2014). There are several perceived barriers to physical activity experienced by children with ASD such as behavioral problems, poor motor skills, and the tendency to prefer to participate in screen time (Must et al., 2015). As the number of parent perceived barriers to physical activity increases for children with ASD, the amount of screen time increases and the amount of physical activity decreases (Must et al., 2015). Compared to typically developed peers, children with ASD are less physically fit in the strength domain (Tyler et al., 2014). Participation in exercise programs can lead to increases in physical fitness in children with autism spectrum disorder including increases in strength and aerobic capacity, bringing them up to similar levels as typically developed peers (Pace & Bricout, 2015; Tyler et al., 2014).

Exercise can be used to help children with autism spectrum disorder in many different ways. Not only does an increased amount of physical activity promote a healthy lifestyle in these children, it also helps some of the symptoms of autism spectrum disorder itself. Antecedent exercises, or acute bouts of physical activity, typically done before sessions of learning, have been used as alternative treatments for stereotypic behaviors, social engagement, communication skills, and academic achievement (Lang et al., 2010; Pontifex, Fine, da Cruz, Parks, & Smith, 2014; Sowa & Meulenbroek, 2012).

Review of Exercise Research in Children with ASD

Exercise has been shown to positively affect both the negative and positive behaviors in those diagnosed with autism spectrum disorder. Early research done on the effects of antecedent exercise yielded positive results (Kern et al., 1982). Kern et al. (1982) noted that brief jogging sessions produced decreases in post-session engagement in self-stimulatory behaviors while increasing positive behaviors such as academic responding, being on-task, appropriate ball-play,

and general interest in school-related tasks. The jogging sessions that the children engaged in were done as the child ran for 5 to 20 minutes as the experiment progressed. The child was allowed to slow to a walk for 15 seconds if the child showed any discomfort. The child was meant to be in a state of mildly strenuous exercise. The indicators of this mildly strenuous state were an increased breathing rate and a slightly flushed face (Kern et al., 1982). Increased breathing rate and slightly flushed face are not strong indicators of exercise state. Each child could experience an increased breathing rate and flushed face at different levels of exertion. Some children become flushed right away while exercising and others might take a long time to become flushed. In future research a more scientific method, such as heart rate, might be used to determine level of exertion for the child. A positive note, however, is that the child's physician was contacted to determine what length of session, and pace of the jog that would be appropriate for the child. Later research should also include a consultation with the child's physician to determine the child's ability to complete mildly strenuous exercise. Kern et al. (1982) suggests that further research should be done to note the differences in various types of self-stimulatory behavior post-exercise, and determine if there is a specific amount, type, or duration of physical activity that is most influential on negative and positive behaviors in children with autism spectrum disorder.

A study done by Power et al. set out to note the difference in self-stimulatory behaviors before and after antecedent exercise bouts in an 8-year old boy with symptoms of autism spectrum disorder (Power et al., 1992). Similar to the findings of Kern et al. (1982) the results indicated that self-stimulatory behavior was dramatically decreased after antecedent exercise bouts, while at the same time increasing on-task behavior. The form of antecedent exercise used in this study was roller-skating outdoors on a large oval sidewalk for 10 minutes. It was noted

that roller-skating was used as it was thought to be a reinforcing form of exercise for the child. The study did not mention any methods used to determine if the exercise bout was at all strenuous (Power et al., 1992). It was then suggested that further research should determine other effective forms of antecedent exercise.

To determine if exercise intensity had an effect on stereotypic behaviors in children with autism Levinson and Reid (1992) implemented a walking versus jogging exercise protocol. The main difference of this study from other studies in the past was to differentiate between the exercise intensities with precise methodology (Levinson & Reid, 1992). Two males and one female all aged 11-years-old all having the diagnosis of autism spectrum were selected as they were determined to be low-functioning and stereotypic behaviors have been noted to occur more in low-functioning individuals with autism. The participants were first observed for two weeks to gather baseline stereotypic behavior data. Following baseline, the children were put through two different experimental exercise conditions of mild and vigorous intensities. The mild exercise intensity included walking around a field and was determined by pre-and post-exercise heart rate monitoring. Similarly, the vigorous exercise intensity condition of jogging was measured through the use of pre- and post-exercise heart rates. It is important to note that heart rate was determined through palpation of the radial pulse before and after each session. The researchers wanted to have the participants wear heart rate monitors but the participants refused to wear them (Levinson & Reid, 1992). Heart rate monitor data would be more reliable than palpating the radial pulse. Before and after each exercise session, the stereotypic behaviors of each participant were observed for 45 minutes. The exercise sessions alternated between walking and jogging every other week and lasted 15 minutes and occurred once a week. The intervention lasted 5 weeks and an additional 2 weeks of monitoring was done to determine the treatment

effects of the exercise program. It was determined that vigorous exercise was most effective in reducing stereotypic behaviors. The treatment effects post-exercise session only lasted 1.5 hours after levels of stereotypic behaviors returned to or exceeded their pre-exercise frequencies (Levinson & Reid, 1992). The hypothesis that stereotypic behaviors, since maintained by sensory feedback, might be eliminated or replaced by activity that produced similar sensory consequences was supported. This is important as other activities that fulfill the function of stereotypic behaviors could be used in the future.

Similar to the study done by Levinson and Reid, Celiberti et al. (1997) wanted to determine the difference in stereotypic behaviors after different intensities of exercise. The main focus of this particular research, however, was to determine the specific changes in maladaptive stereotypic behaviors or the behaviors that most affected skill development in a 5-year-old boy (Celiberti et al., 1997). The exercise protocol only lasted for 6 total minutes, and no physiological measures were taken to determine the intensity of the exercise. Results indicated that this was a useful tool in decreasing motor related self-stimulatory behaviors than visual self-stimulation (Celiberti et al., 1997). The child's most disruptive behaviors were most affected by the intervention. Future research should have a longer exercise period as most daily recommendations for exercise exceed 30 minutes and include a way to measure exercise intensity.

A study done by Prupas and Reid (2001) further substantiates the fact that children with autism might not be willing to comply with methods for obtaining heart rate measurements. This study also showed that multiple frequency exercise programs are better at reducing stereotypical behaviors (Prupas & Reid, 2001). Furthermore, the study indicates that a specific time of day and classroom environment might be important confounding factors to any antecedent exercise study.

The researchers did take into account maximum heart rate and intensity when establishing the jogging treatment. The researchers were specifically looking at the differences in stereotypic behavior among exercise frequencies. One experimental method was a single frequency of jogging at a specific time of day for 10 minutes at 65%-70% of maximal heart rate (220-age). The other experimental condition was exercising at 65%-70% of maximal heart rate in three different 10 minute sessions throughout the day (Prupas & Reid, 2001). When the participant was unwilling to have their heart rate measured, the researchers noted the participants refused both the heart rate monitor and palpation of radial pulse, the researchers noted flushed face and increased breathing rate as a measure of the intensity (Prupas & Reid, 2001). Further research should determine an appropriate placement for exercise in a school day and show the effects of play and sport decrease stereotypic behaviors and increase social inclusion.

More recent research has looked at how antecedent exercise affects not only stereotypic behaviors but academic engagement and social dysfunction as well. Nicholson et al. (2011) focused on the impact of antecedent exercise on academic engagement. The researchers used a high functioning ASD population as they are more likely to be introduced in the general education classroom setting (Nicholson et al., 2011). A 12-minute jogging plus a 5-minute cool down intervention was used. Exercise was determined based on the length of jogging interventions used in previous studies. Data was also taken on time spent running and distance covered (i.e. steps, miles, and laps) to prove engagement in the study (Nicholson et al., 2011). Steps might also be another way to ensure the child is exercising. To ensure that the child remained jogging throughout the intervention a paraprofessional and/or gym teacher ran alongside them (Nicholson et al., 2011). This type of encouragement might be important to the proposed study in order to ensure our participants are engaged in the antecedent exercise

protocol we are teaching them. The results of the study done by Nicholson et al. (2011) indicated that antecedent exercise increases academic engagement and that academic engagement increases as the amount of time spent engaged in the exercise increases. It was inconclusive as to whether or not increased levels of academic engagement continued after the intervention was removed.

Morrison et al. (2011) conducted an antecedent exercise experiment with the purpose of extending the field by using methodological advances related to applied behavior analysis. The researchers utilized functional analyses to ensure that problem behaviors were maintained by automatic reinforcement, used a preference assessment to determine the child's preferred exercise activity, used a three-component multiple schedule for evaluating the immediate and subsequent effects of the exercise, and finally, evaluated the post-intervention effects of exercise versus leisure items by implementing a multiple-schedule test sequence and two control sequences (Morrison et al., 2011). The functional analysis done on each participant in the study was to determine if the behaviors were maintained by automatic reinforcement and not social reinforcement. As exercise could fulfill the sensory needs of automatic reinforcement, it is important to rule out social reinforcement because exercise could become an abolishing operation for problem behaviors. A preference assessment was done to determine what type of antecedent exercise the participant was interested in. Some of these exercises included: using a therapy ball, using a scooter board, riding a stationary bike, and using moon shoes. There was no methodology employed by the researchers to determine if these activities were exercise or not (Morrison et al., 2011). The researchers argue that these activities were beneficial as many people with developmental disabilities are unable to complete other forms of exercise such as jogging as they do not have the skills necessary to jog (Morrison et al., 2011). Results indicated

that a multiple component schedule might be useful in evaluating the maintenance effects of antecedent exercise and that antecedent exercise is more effective than presentation of leisure items. Morrison et al. (2011) concluded that antecedent exercise is not necessarily the only factor that lowers automatically reinforced behavior. It is suggested that antecedent exercise, though effective, might be used as one component in a treatment package to help decrease these behaviors in the future.

In a study done by Oriel et al. (2011) done to determine the effects of antecedent exercise on academic engagement, it was shown that antecedent exercise was very beneficial in increasing correct academic responding, improving on-task time, and decreasing stereotypic behaviors. A 15-minute jogging period was used as the treatment condition and flushed face and increased breathing rate were used to determine if the exercise bout was strenuous (Oriel et al., 2011). Measurement of heart rate was reported to not be tolerated by any of the participants. Though antecedent exercise was generally helpful based on the results of the study, the researchers concluded that no results shown in various participants could be due to the participants not exercising for as long of a duration as those who showed progress (Oriel et al., 2011). The researchers mentioned energy expenditure of the participants who were less engaged to be lower, however, since no objective measure of exercise rate was used, this speculation needs to be explored more fully.

Other exercises interventions besides jogging have been tested to determine whether or not they are effective in reducing stereotypic behavior and increasing positive social and academic behaviors. Bahrami et al. (2012) and Movahedi et al. (2013) both found that utilizing Kata karate techniques decreased stereotypy and improved social dysfunction in children with ASD. Though the Kata techniques were shown to be effective in reducing stereotypic behaviors,

this is a mild form of exercise, and the resemblance of the repetitive movements of the different punches and kicks could account for reduction in stereotypy (Bahrami et al., 2012; Movahedi et al., 2013). The most important finding of Movahedi et al. (2013) and the study on how Kata techniques influence social dysfunction, was that after 30 days of no participation in Kata, the participants still exhibited significantly lower levels of social dysfunction.

Trampoline jumping was used as the exercise intervention in a study done by Neely, Rispoli, Gerow, and Ninci (2015). The participants in the study were two children aged 7-8 with ASD. No measures were done to indicate exercise was occurring (Neely et al., 2015). The participants jumped on the trampoline until they were satiated of the exercise bout. This study still yielded positive results, indicating that antecedent exercise decreased stereotypic behavior (Neely et al., 2015). However, jumping on a trampoline until satiation could fulfill the function of stereotypic behaviors. The lack of exercise measures and the satisfying of the function of the behavior indicates that this might not be an accurate representation of the benefits of antecedent exercise.

Losinski et al. (2017) completed a study that determined the effectiveness of deep pressure therapies and antecedent exercise in reducing stereotypical behaviors of three boys aged 7-11 with ASD. During the antecedent exercise component of the study, the participants were instructed to ride an exercise bike for 10 minutes at a predetermined speed and resistance. The exercise condition was set at a rate that would allow the participant to increase his heart rate to approximately 100 beats per minute or half of his maximal heart rate (Losinski et al., 2017). Heart rate was only measured during the predetermination phase, not continuously during the study. Additionally, 100 beats per minute is around the resting heart rate levels in typically developed children. Moderate to vigorous levels of physical activity raises heart rate to between

65% and 95% of maximal heart rate levels. Training could occur during the experimental phase. The inconsistent measure of heart rate, and the exercise heart rate being close to resting heart rate during the exercise condition might explain the results of the study not indicating any difference in observed stereotypical behaviors and attention during direct instruction. Stereotypical behaviors were decreased by nearly half in two of the students which was socially valid though not a significant finding of the study. Antecedent exercise also had more social validity compared to the deep pressure therapies amongst the teachers and paraeducators interviewed in the study (Losinski et al., 2017). Future research needs to be done with consistent heart rate measurement and at moderate to vigorous exercise intervals.

Literature reviews on antecedent exercise examined the effects on various types of behaviors. A majority of the exercises in the literature reviews were running or jogging though results of studies where other exercises were done were included in the reviews as well. Some of these other exercises include: swimming, water aerobics, stationary bike riding, lifting weights, treadmill walking, roller-skating, stretching, snowshoeing, horseback riding, martial arts, yoga, and dance (Bremer et al., 2016; Lang et al., 2010; Petrus et al., 2008; Sowa & Meulenbroek, 2012). The reviews of literature did not specify or scrutinize if heart rate was measured to determine exercise. The reviews all concluded that there is not enough evidence in the field of antecedent exercise but that antecedent exercise has short-term effects such as decreasing stereotypic behaviors and increasing social-emotional functioning, cognition, and attention (Bremer et al., 2016; Lang et al., 2010; Petrus et al., 2008; Sowa & Meulenbroek, 2012).

Exercise in Children with ASD

There are some contraindications for exercise in children with autism spectrum disorder such as impairments in movement skills, and low heart rate response. Approximately 50-70% of

children with autism spectrum disorder have movement impairments (Green et al., 2009). Some studies even suggest that motor impairments might be found in all children with autism spectrum disorder (Dewey, Cantell, & Crawford, 2007). Movement impairments can include problems with balance and gait, slower speed of timed movements, greater overflow movements, and problems with gesture imitation (Green et al., 2009). Additionally, children with ASD have been noted to experience problems with motor planning, motor coordination, fine motor skills, and gross motor skills (Dewey et al., 2007). This could be due to the fact that autism spectrum disorder can be accompanied by other neurological deficits, including those necessary to complete various movements (Dewey et al., 2007; Green et al., 2009). It is important to note that children with ASD experience problems with mirroring gestures as they could potentially lack the neural substrate for self-other mapping as well as other sensory processes (Dewey et al., 2007). This could potentially affect the participants' performance in the proposed study, as they could struggle to complete the various athletic tasks. Additionally, it is important to understand that those children with lower cognitive abilities might have lower motor function (Green et al., 2009). Deficits in overall motor ability could impact the participants' ability causes difficulties with balance, flexibility, or movement speed which could result in joint injury (Pace & Bricout, 2015).

Children with ASD have lower resting heart rates than the general population (Pace & Bricout, 2015). The physiological stress response in these children is impaired, which means that autonomic responses to stress, physical, mental and social, occurs more infrequently than the typical population (Pace & Bricout, 2015). Chronic anxiety experienced by those with ASD could lead to a down regulation of the autonomic nervous system (Pace & Bricout, 2015). This indicates that the heart rate is not elevated in times of stress, therefore those with ASD have

lower resting heart rate. Children with ASD also have a decreased heart rate response to exercise. Lower heart rate could be problematic as abnormal heart rate responses can lead to cardiovascular disease (Pace & Bricout, 2015). It is important to understand this lower heart rate response when taking measurements during exercise. Additionally, a lower heart rate response in children with ASD should indicate the importance of utilizing heart rate measures on these individuals during exercise. Exercise is vital for children with ASD in order to increase aerobic capacity and prevent their increased risk of cardiovascular disease.

Social Benefits of Sports in Children with ASD

Peer-mediated social skills interventions have been shown to be effective in assisting children with ASD with social involvement. Peer-mediated interventions are defined as those that involve training peers to implement elements of behavioral interventions. Peer-mediated interventions are also effective when included in a treatment package with other evidence based practices. A peer network is one example of a peer-mediated treatment package. This peer network includes a focus child with autism spectrum disorder and a small group of typically developed peers that were nominated by the teacher utilize peer mediation along with teacher instruction to obtain results. This allows for more help for students with ASD in integrated settings. One area where peer-mediated interventions have been shown to be effective is during recess. The purpose of the study done by McFadden et al. was to determine if a peer network recess intervention package would be an effective tool in increasing reciprocal social communication behavior in children with ASD. In order to implement the peer network recess intervention package, the implementers of the study first taught a class-wide social skills lesson to both peers and the child with ASD. The social skills class covered the following areas: playing together and having fun; complimenting and encouraging our friends; talking about what we're

doing and giving ideas; and using names and getting attention. The skills were referenced again at various points during recess time throughout the course of the study. Results showed notable increases in both the participants and the peers in social communication behavior during recess time. The study demonstrated that use of a peer network recess intervention package was a successful tool to use to increase social behaviors and peer interactions in children with autism spectrum disorder. The researchers noted that interventions that simultaneously target peer and participant behavior can result in desirable behavior changes.

Sport participation can result in various social benefits for children with ASD (Ohrberg, 2013). Generally, team sport participation has been shown to decrease mental health problems in teenagers and children (Eime et al., 2013). Team sport involvement increases feelings of social acceptance and reduces shyness and anxiety (Eime et al., 2013). Special Olympics involvement has been shown to reduce stress, increase quality of life, and increase self-esteem in individuals with intellectual disabilities (Robertson & Emerson, 2010). Robertson and Emerson (2010) found that individuals involved in Special Olympics report higher scores in their relationships than those who do not participate suggesting social benefits. Similarly teaching children with autism a sport or athletic activity increases positive social behaviors and decreases antisocial behavior problems (Movahedi et al., 2013; Pan, 2010). Movahedi et al. (2013) found that social effects of learning a sport maintain after the intervention is over. Pan (2010) found that children with ASD decreased in antisocial behaviors during a swim skill intervention, especially where they could observe positive interactions between their instructors and peers. The social impact of a basketball intervention could increase positive social behaviors in children with autism spectrum disorder.

Athletic Skill Acquisition in ASD

Relatively few studies have been done concerning the skill acquisition of children with ASD in athletics. One of the earlier studies on motor skill acquisition by Reid et al., tried to determine whether visual/verbal prompting or physical/verbal prompting was better for children with ASD when they were learning new motor skills. It was found that reinforcement, task analysis, and physical prompting in particular were important for motor skill improvement in people with ASD (Reid et al., 1991). An additional study showed that teaching individual swimming skills to preschoolers with ASD is possible if the child is taught the skill through direct instruction and the instruction and expectations are paired to his or her unique skill level (Prupas et al., 2006). Additionally, if parent instruction and guidance is reinforced by a coach, this solidifies skill development of the child (Prupas et al., 2006). In a study done by Yilmaz et al. (2010) it was found that children with ASD were able to learn a simple swim stroke progression with the method of most to least prompting. The results stated that all of the participants within the study greatly increased in the correct target skills during the intervention phase of the study and were able to maintain the skills through 4 weeks of generalization (Yilmaz et al., 2010). Additionally, it was shown that most to least prompting methodology was an effective tool to teach athletic skills (Yilmaz et al., 2010). Swimming skills were observed in a study done by Chu and Pan (2012) as well. The intervention of implementing peers or siblings as learning assistants in teaching swimming to children with ASD showed that both the children with ASD and their child mentors increased in the appropriate aquatic skills (Chu & Pan, 2012). The research also stressed the importance of identifying each child's unique strengths, weaknesses, and learning in teaching athletic skills (Chu & Pan, 2012). Furthermore, it was shown that extremely specific task cues help the children with ASD be more successful in

athletic skills (Chu & Pan, 2012). Miltenberger and Charlop (2014), sought to teach athletic group play to children with ASD that would allow for them to be able to handball or four-square at recess with typical peers. It was found that all three of the children in the study improved their demonstration of and mastered all of the target athletic skills of both of the games done in the study (Miltenberger & Charlop, 2014). Moreover, it was shown that the mastery of the athletic skills, and gameplay rules, allowed the children with ASD to increase in their interactions with typical peers (Miltenberger & Charlop, 2014).

Future Research

Based on the literature, exercise intensity and type needs to be addressed in children with autism. An accurate exercise prescription must be determined. The exercise that should be done should somehow fulfill the sensory input need of the stereotypic behavior. Exercise that is more aerobic in nature would be beneficial in fulfilling daily exercise recommendations, in increasing positive academic behaviors, and in decreasing competing behaviors. Additionally, sport has been shown to be important in assisting children with disabilities in increasing positive social behaviors. Children with ASD have the capacity to learn athletic skills, and this has been reported to improve both health and social functioning.

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APPENDIX B

Task Analysis and Treatment Fidelity

Task Analysis / Treatment Fidelity

Triple Threat or "Ready Position"

1. Stand with legs shoulder width apart or stand with both feet on markers
2. Pick up ball with both hands (only necessary if the person does not yet have the ball)
3. Hold ball in both hands with a hand on each side of the ball, and the ball in front of your stomach.
4. Bring your right foot forward so that the middle of your right foot lines up with the toes of your left foot
5. Slightly bend both knees.
6. While still holding on to the ball, move your arms to your right, so that the ball is now in front of your right hip. (tape will be put on hip to indicate correct position)
7. You are now in triple threat or ready position.

Dribbling--teach movement without the ball first

1. Start in triple threat or ready position with the ball on the right hip
2. Move right hand from side of the ball to the top of the ball. Let go of the ball allowing the ball to drop to the ground by taking away your left hand.
3. Have your right arm ready for the ball by having your elbow bent to 90, your wrist straight and parallel to the ground, and the fingers spread apart.
4. When the ball bounces back up into your hand, keep the wrist solid and stiff and straighten your elbow, pushing the ball back towards the ground.

- Always have your arm ready for the ball to bounce back up.
- Each time the ball bounces back up into your hand repeat the elbow straightening movement to push the ball towards the ground.
- Dribble at least 10 times before stopping and picking up the ball when it bounces up with both hands

Dribbling while walking or jogging--after stationary dribbling

1. Same movement as stationary dribbling but with each step dribble once and then when the ball bounces up pick it up with two hands.
2. Once mastered introduce continuous dribbling while walking
3. Once mastered introduce continuous dribbling while jogging

Shooting

1. Be close to the basket and facing the basket
2. Start in triple threat or ready position
3. Have your shoulder be square to the basket; make sure your shoulders are facing the basket with your shoulders being lined up with the hoop. Be straight in front of the basket.

4. Move your dominant hand so it is on top of the ball and your non dominant hand is on the side of the ball. (hands will be drawn in correct position on individual balls)
5. Bend your knees a little more than you do in ready position--could be something to teach before (go down height 1, go down height 2)
6. All together straighten your legs as you bring your arms up toward your face with your elbows and wrist bent.
7. Once in front of face straighten your elbows pushing the ball towards the hoop.
8. Finish with your wrist flicked, fingers pointing towards the ground. As if you are reaching into a cookie jar high above your head.

Defensive slides

1. Start in a position similar to triple threat or ready position but without the ball.
2. Stand with your chest facing the sideline.
3. Keeping your knees bent, begin to move side to side with your front foot. Your front foot always moves first.
4. Follow the same directional movement of your front foot with a slide movement of your back foot but never let the two feet come close together. Ready position is the closest your feet ever come together. (Markers will be placed on the floor to indicate where each step must be)
5. Continue with the same front foot back foot motion with the knees remaining bent all the way down the court.

- Teach walking first, then bent knees, then half speed, then full speed slides

APPENDIX C

Classroom Observation Form

Classroom Observation Form

Child: **Observer 1:**

Session: **Pre** **Post** **Observer 2:**

Date:

	:10	:20	:30	:40	:50	1:00	:10	:20	:30	:40	:50	2:00
On Task												
Disruptive												
Repetitive Bx												

	:10	:20	:30	:40	:50	3:00	:10	:20	:30	:40	:50	4:00
On Task												
Disruptive												
Repetitive Bx												

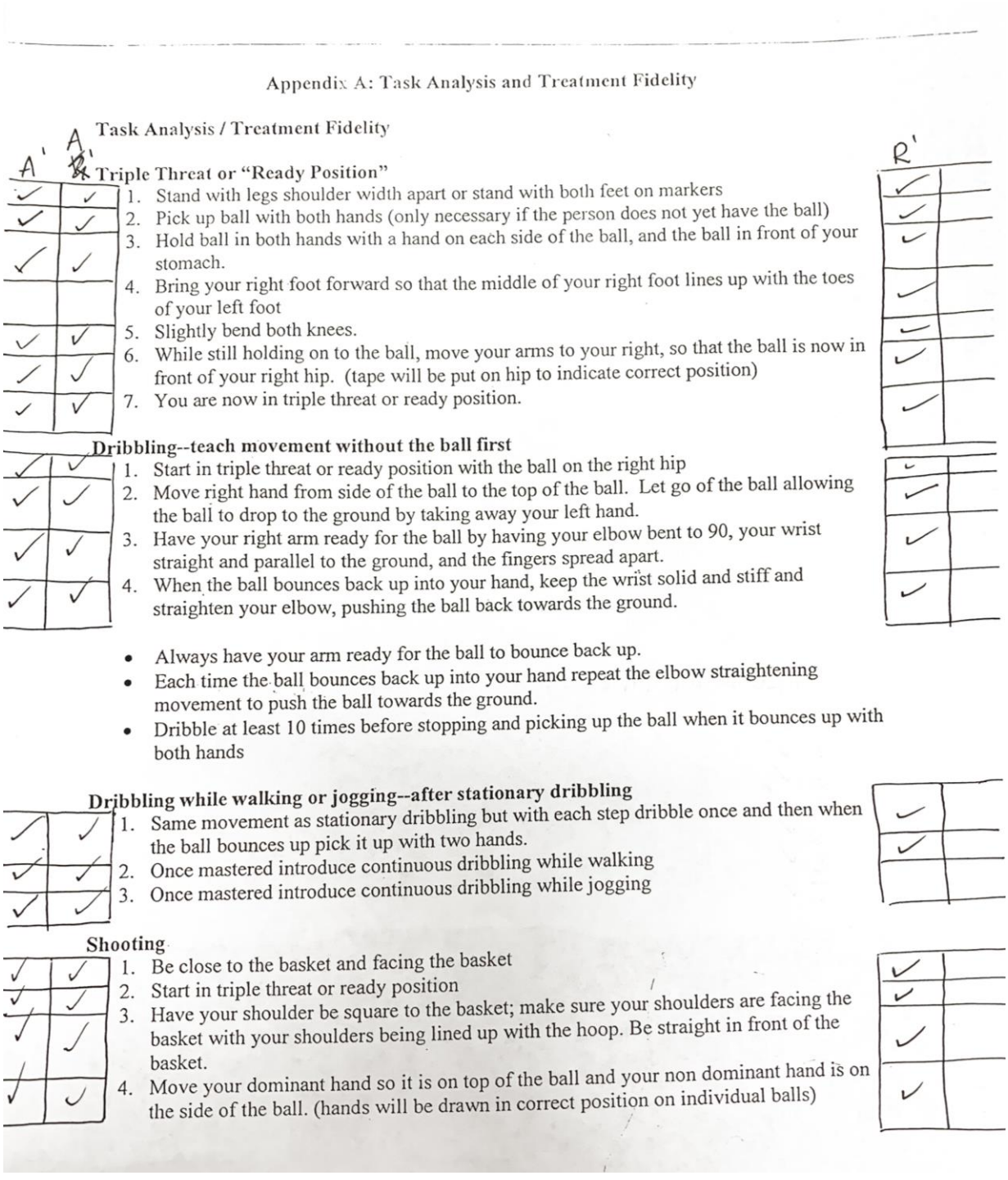
	:10	:20	:30	:40	:50	5:00	:10	:20	:30	:40	:50	6:00
On Task												
Disruptive												
Repetitive Bx												

	:10	:20	:30	:40	:50	7:00	:10	:20	:30	:40	:50	8:00
On Task												
Disruptive												
Repetitive Bx												

	:10	:20	:30	:40	:50	9:00	:10	:20	:30	:40	:50	10:00
On Task												
Disruptive												
Repetitive Bx												

APPENDIX D

Basketball Intervention Observation Form



Appendix A: Task Analysis and Treatment Fidelity

Task Analysis / Treatment Fidelity

Triple Threat or "Ready Position"

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- Dribble at least 10 times before stopping and picking up the ball when it bounces up with both hands

Dribbling while walking or jogging--after stationary dribbling

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2. Once mastered introduce continuous dribbling while walking
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Shooting

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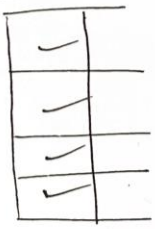
8. Finish with your wrist flicked, fingers pointing towards the ground. As if you are reaching into a cookie jar high above your head.



Defensive slides

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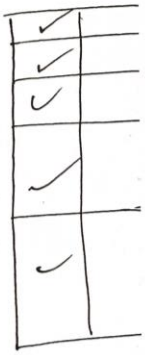
3. Keeping your knees bent, begin to move side to side with your front foot. Your front foot always moves first.
4. Follow the same directional movement of your front foot with a slide movement of your back foot but never let the two feet come close together. Ready position is the closest your feet ever come together. (Markers will be placed on the floor to indicate where each step must be)
5. Continue with the same front foot back foot motion with the knees remaining bent all the way down the court.



- Teach walking first, then bent knees, then half speed, then full speed slides

PROGRAM FIDELITY

1. ✓
2. ✓
3. ✓
4. ✓
5. ✓
6. ✓
7. ✓

APPENDIX E: Treatment Fidelity Checklist

Treatment Fidelity

1. Starts session with running

2. Uses least to most prompting (model, verbal, partial physical, full physical)

3. Provides corrective feedback

4. Introduces skills sequentially during instruction

5. Provides sufficient verbal praise

6. Uses positive affect

7. Provides sufficient opportunities to respond

APPENDIX F: Parental Permission Form

Parental Permission for a Minor

Introduction

My name is Blake Hansen. I am a professor from Brigham Young University. My graduate student Erika Richards and I are conducting a research study to determine if a basketball program is beneficial to children aged 8-11 with autism spectrum disorder to decrease repetitive and off-task behaviors and help with an academic goal and social skills. We received your information from your child's teacher, [Ms./Mr.]. We are inviting your child to take part in the research because (he/she) is currently attending special education classes with a current Individualized Education Plan, and has a diagnosis of autism spectrum disorder.

Procedures

If you permit your child participate in this research study, the following will occur:

--You must give permission for the researchers to obtain access to an IEP. We will access your child's IEP and existing test results to help support your child's participation in the study.

--Baseline information on your child will be measured for a minimum of 3 days on repetitive behaviors, on-task behavior, and heart rate for 10 minutes. This will be done in the classroom.

--Your child will be provided with an Apple Watch or Fitbit to wear while participating in the study. The purpose of the Fitbit is to measure their heart rate before, during, and after the intervention.

--A Basketball Program will be done in the school gymnasium and will last for approximately 25 minutes.

--You will be informed of the days your child will be completing the study so that you can provide gym clothes that they are comfortable to exercise in.

--Your child will be taught to play basketball and will do activities like learning to dribble, play defense, jog around the gym, and shooting the basketball.

-- The number of repetitive behaviors, on-task behaviors, and heart rate will be measured for 10 minutes before and after the basketball program.

--The time commitment is three times a week for four weeks. Each session will last about 30 minutes. Total time commitment will be approximately 12-14 hours.

Risks

The children may feel boredom or frustration that they are being asked to do physical activities. There is a minor risk of loss of privacy until the study is complete and names and personal identifiable information is removed. If children begin to engage in more serious behaviors during a session (namely tantrums that involve the child collapsing to the ground, yelling loudly for more than 1 minute, or crying for more than one minute without interruption; physical or verbal aggression, or self-injurious behaviors) sessions will be terminated. There is also a minor risk for musculoskeletal injury but we will keep ice on hand and send them to the school nurse. An additional risk of emotional harm associated with basketball might occur but we plan to only give praise about their skill development. To protect privacy, all data will be stored in a locked filing cabinet or a password protected computer.

Confidentiality

Paper observation forms will be kept and coded into a spreadsheet. Consent forms, and strengths and difficulties questionnaires will be kept. These files will be stored in a filing cabinet in the Blake Hansen's office (343 MCKB, Brigham Young University) under lock and key. Your child's name will be changed on all data sheets to protect their identity. Spreadsheets with information on the participants will be generated. These spreadsheets will be stored on a password protected computer. Only Blake Hansen and Erika Richards will have access to data. The data will be kept for three years after completion of the study.

Benefits

There are no direct benefits for your child at this time as we are trying to establish if there is a benefit to implementing a basketball program for children with autism spectrum disorder through this study.

Compensation

There will be no compensation for participation in this project.

Questions about the Research

Please direct any further questions about the study to Blake Hansen at 801-422-4691 or blake_hansen@byu.edu. You may also contact Erika Richards at 480-285-7983 or ejrichards22@yahoo.com.

Questions about your child's rights as a study participant or to submit comment or complaints about the study should be directed to the IRB Administrator, Brigham Young University, A-285 ASB, Provo, UT 84602. Call (801) 422-1461 or send emails to irb@byu.edu.

You have been given a copy of this consent form to keep.

Participation

Participation in this research study is voluntary. You are free to decline to have your child participate in this research study. You may withdraw your child's participation at any point without affecting your child's grade/standing in school.

Child's Name: _____

Parent Name: _____ Signature: _____ Date: _____