ABSTRACT

BEING A SOCIAL CLIMBER: THE EFFECTS OF A ROCK CLIMBING INTERVENTION ON THE SOCIAL INTERACTIONS AND MOTOR SKILLS OF INDIVIDUALS WITH AUTISM SPECTRUM DISORDER

Adolescents diagnosed with Autism Spectrum Disorder (ASD) are often less physically active and less involved in the community than their typically developing peers. This is a major cause for concern because there are many detrimental outcomes of having a physically inactive and secluded lifestyle. Indoor rock climbing may be a good option for adolescents diagnosed with ASD to be involved in the community while getting exercise, due to the sport's physical and social characteristics. A nonconcurrent multiple baseline design across participants with a reversal was used to examine the effects of an interdependent group-oriented contingency on the social interactions between adolescents with ASD and their typically developing peers while rock climbing at an indoor climbing and fitness gym. Social interactions were measured by the rate of positive, negative, and neutral interactions between the participant and peer. The participants' motor proficiency was also measured prior to and at the end of the study. The results demonstrated that the participants engaged in higher levels of positive social interactions, variable levels of neutral interactions, and zero levels of negative interactions during the interdependent group-oriented contingency phase. All of the participants' motor proficiency scores had increased by completion of the study.

Geoffrey Browning
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BEING A SOCIAL CLIMBER: THE EFFECTS OF A ROCK CLIMBING INTERVENTION ON THE SOCIAL INTERACTIONS AND MOTOR SKILLS OF INDIVIDUALS WITH AUTISM SPECTRUM DISORDER

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CHAPTER 1: INTRODUCTION

The 2008 Physical Activity Guidelines (PAG) were created by the United States Department of Health and Human Services to inform the public the types and amounts of physical exercise that may mitigate a number of health risks. These include a reduced risk of a number of adverse health conditions, injury, and the loss of functional abilities associated with aging, as well as improved mental health outcomes. The lifelong health benefits of an active lifestyle apply to any individual regardless of their gender, age, ethnicity, physical ability, or mental capacity (U.S. Department of Health and Human Services, 2008). One group of people failing to meet national standards for physical activity are children diagnosed with Autism Spectrum Disorder (ASD) (Bandini et al., 2012; Must et al., 2014; Pan, 2008).

Autism Spectrum Disorder (ASD) is a prevalent disorder occurring at a rate of 1 in 68 children (Centers for Disease Control and Prevention, 2014) and is characterized by qualitative impairments in social interactions, delays or lack of communication, and restrictive or repetitive patterns of behavior (American Psychiatric Association, 2013). Two common health problems for children with ASD include being overweight or obese (Curtin, Anderson, Must, & Bandini, 2010) and engaging in low levels of physical activity (Bandini et al., 2012; Pan, 2008; Must et al., 2014). Although children with ASD face many obstacles to participation in physical activity, research shows that organized exercise interventions often produce substantial improvements in their social and motor development (Sowa & Meulenbroek, 2012). Indoor rock climbing may be a good option for children with ASD due to the sport’s physical and social dynamics.

The PAG suggest that a *socio-ecological* approach should be used to improve the publics' physical activity, which means that all levels of society including individual, interpersonal, organizational, community, and public policy, must take action. PAG's suggestions for increasing physical exercise are similar to those proposed by Hörst (2008) to be beneficial when learning to rock climb: setting individual climbing goals, climbing with a partner, and being a part of a climbing community. Hörst explained that the social aspects of rock climbing are important, and that other climbers often serve as a resource of knowledge and motivation. While this may be true for many typically developing individuals, it may not be true for individuals with ASD. Individuals with ASD may not benefit from the information or feedback provided by peers and may also find it difficult to provide information and feedback for peers while climbing. One intervention that has shown to increase peer interactions for children with ASD is an interdependent group-oriented contingency.

CHAPTER 2: LITERATURE REVIEW

The PAG provides information and recommendations for three areas of physical activity: aerobic activity, muscle-strengthening activity, and bone-strengthening activity. Children and adolescents (ages 6-17) should engage in aerobic exercise for 60 minutes every day, most of which should be moderate or vigorous intensity. As part of the 60 minutes a day of aerobic exercise, muscle-strengthening exercises should occur 3 days a week. These muscle-strengthening exercises should be age-appropriate such as climbing on a jungle gym, playing tug of war, or during a structured activity like lifting weights. Bone-strengthening activities are activities that produce force on the bones when the body makes impact with the ground. Bone-strengthening activities should also occur 3 days a week and can also be aerobic and muscle-strengthening activities such as playing basketball, tennis, jumping rope, or running (U.S. Department of Health and Human Services, 2008).

Despite the benefits of regular physical exercise, many children, both typically developing children and children diagnosed with ASD, fail to achieve adequate levels in their daily lives. In 2013, the CDC collected national data on health statistics on children and adolescents' weight and physical activity. The results indicated that, of the adolescents surveyed, 16.6% were considered overweight and 13.7% were considered obese. The results on physical activity indicated that only 27.1% of the adolescents were physically active on a daily basis. The CDC also found that only 38.5% of children ages 9-13 participate in any organized physical activity during non-school hours (Centers for Disease Control and Prevention, 2014). Although the health statistics for typically

developing children are below national standards, the health statistics for children and adolescents diagnosed with Autism Spectrum Disorder are worse.

Curtin et al. (2010) conducted a secondary analysis of the National Survey of Children's Health (NSCH) to investigate the obesity rates for children diagnosed with ASD. The researchers found that 30.4% of children diagnosed with ASD were considered obese compared to 23.6% of children without ASD. Phillips et al. (2014) used data collected by the National Health Interview Survey (NHIS) from 2008- 2010 and found that obesity rates for adolescents ages 12-17 diagnosed with ASD are greater than their typically developing peers (31.8% compared to 13.1%). One possible reason children with ASD are more likely to be overweight may be due to their physical activity level.

Pan (2008) used an accelerometer to compare the amount of moderate-to-vigorous physical activity (MVPA) that children with ASD and typically developing children engaged in during recess. Results indicated that children with ASD were less active than typically developing children during recess. Bandini et al. (2012) found that activity levels for children with ASD were similar to typically developing children (50 minutes/day vs. 57.1 minutes/day); however, children with ASD participated in significantly fewer types of physical activities and less time engaged in physically activity throughout the year compared to their typically developing peers. Must et al. (2014) used parent questionnaires to compare children's sedentary behaviors throughout the week. The researchers found that children with ASD spend more time engaged in sedentary behaviors than children without ASD on both the weekdays (5.2 hours/day vs. 4.2 hours/day) and on the weekends (7.3 hours/day vs. 6.9 hours/day). Children with ASD spent more of their sedentary time engaged with electronic devices, when compared to children without ASD, on both the weekdays (2.5 hours/day vs. 1.6 hours/day) and

on the weekend (3.9 hours/day vs. 3.1 hours/day). In response to the growing problems of obesity and physical inactivity displayed by children and adolescents diagnosed with ASD, research should focus on increasing rates of physical activity. This could involve increasing the time spent engaged in current physical activities or increasing the types of physical activity. The PAG advises that individuals with disabilities should engage in the appropriate types and amount of physical activity according to their abilities (U.S. Department of Health and Human Services, 2008).

Motor Deficits for Children with ASDs

Research on motor abilities is often categorized into many domains including gross and fine motor coordination, posture, balance, strength, gait, imitation, stereotypies, and object manipulation. Bhat, Landra, and Galloway (2011) conducted a meta-analysis to examine the current research on motor functioning displayed by infants, children, and adults' diagnosed with ASD. The researchers found that school-age children and adults with ASD show measurable impairments in gross motor coordination, fine motor coordination, motor stereotypies, posture, praxis, and imitation. Forti et al. (2010) investigated the motor deficits of children diagnosed with ASD by testing whether their deficits were due to their ability plan a motor task or their ability to show motor control while doing the task. To answer this question, the researchers did a kinematic analysis (analyzing the velocity, duration, acceleration, and trajectory of their hands) for a reach and drop test. The study included 12 preschool aged children diagnosed with ASD and 12 typically developing children, matched for age and gender. The reach and drop test required the participants to have their hand in a starting position, reach and grab a ball, fit their hand and ball inside of a box, and

drop the ball. The researchers defined the planned-based movement as the participants reaching and grabbing the ball and the control-based movements were defined as the participants dropping the ball inside the box. The researchers found no differences between the two groups for executing planned based movements, but children with ASD performed poorly on executing control-based movements. More specifically, when engaged in control-based movements, the children with ASD moved with less accuracy and at a faster speed than their typically developing peers. The researchers suggest that children with autism often fail to take in all of the visual information to change their movements in a way that the environment demands. Morris et al. (2015) found similar results about the differences individuals with ASD and typically developing people use visual information to control posture. During the experiment, participants were asked to stand on a portable force platform that was located 1.5 m from a white wall and to look at a black horizontal line on the wall. The researchers measured postural control by sensors that detected foot pressure and movement. The participant's visual information was manipulated when they wore liquid crystal spectacles that could be changed from translucent to opaque under the control of the experimenter. Somatosensory information was manipulated by a vibrating mechanism that was worn on the dorsal neck muscles and shoulders. The results showed that adults with ASD used only somatosensory information to determine their standing posture and ignored visual information while typically developing adults were able to use visual information to override incompatible information provided by the somatosensory system. Understanding that some individuals with ASD may have some sort of motor impairment may be beneficial when finding new sports or exercises to get involved in because it is recommended to weigh the

risks factors associated with the activity and with the individual's health and ability (U.S. Department of Health and Human Services, 2008).

Social Skills Deficits

One of the defining features of Autism Spectrum Disorder is impairment in social skills. Specifically, these include deficits in recognizing and responding appropriately to another person's body language and facial expressions, initiating and maintaining conversations, taking turns during conversations, interpreting nonliteral language, and engaging in perspective taking (American Psychological Association, 2010). Assessing and teaching social skills is an essential part of therapy for individuals with ASD because those who demonstrate poor social skills are more likely to experience detrimental outcomes. Studies have shown that children with poor social skills have fewer friendships, and experience higher levels of peer rejection, social isolation, depression, anxiety, academic failure, and substance abuse (Bauminger & Kasari, 2000; Bellini, 2006; Chamberlain, Kasari, & Rotheram-Fuller, 2007; Howlin & Goode 1998; La Greca & Lopez, 1998).

Due to the importance of teaching social skills to individuals with ASD, many programs and teaching styles have been reviewed for efficacy. Reichow and Volkmar (2010) examined 66 studies between 2001-2008 with a framework of best evidence practices to teach social skills to individuals with ASD. The researchers found that Applied Behavior Analysis (ABA), naturalistic, parent training, peer training, social skills groups, visual supports, and video modeling were all effective at teaching social deficits to individuals with ASD. Although all of these teaching styles were effective, the most common intervention type was ABA. Studies that used ABA were also more likely to augment lessons with other teaching styles. Incorporating multiple teaching styles like peer training or

naturalistic teaching may be critical for children with ASD to generalize newly learned skills to their natural environment. Since one of the goals for children with ASD is to become more socially competent, interventions often include typically developing peers (Koegel, Koegel, Frea, & Freeden, 2001). One option for children with ASD to interact with typically developing peers is through sports, but finding the sport that fits with a child's skills may be difficult.

Difficulties with Team Sports

The psychological and social benefits of team sports have been well documented for typically developing children and adolescents (Eime, Young, Harvey, Charity, & Payne, 2013). Unfortunately, research on the benefits of team sports for children with ASD is limited. The results of a meta-analysis conducted by Sowa and Meulenbroek (2012) on physical exercise interventions for children with ASD yielded no behavioral studies that involved team sports. Although team sports provide ample opportunities for social interactions, the social and physical dynamics of many team sports may be particularly difficult for children with ASD. Most team sports require teammates to play and communicate together, and often times each player must perform at a basic or satisfactory level for the flow of the game to work. For this to happen each individual needs to learn the component skills of that sport in order to be included with their peers. Teaching the component skills of a team sport to a child with ASD may be increasingly difficult if that child has motor deficits. For example, many team sports have transient aspects such as dribbling a basketball, hitting a baseball, or catching a football. When learning these skills, the individual usually has a split second to respond to the visual information of the sport. If the individual does not respond correctly in that moment the learning opportunity is over. In addition to the transient aspect of

many team sports, there are often many written and unwritten rules that need to be followed. This may be difficult for children with ASD if they show deficits in understanding and following instructions or interpreting nonliteral language. Furthermore, team sports are often played in a group context, which often requires the individuals to successfully join a conversation, take turns speaking while listening when others are speaking, and starting conversations about topics that the audience is interested in. Although team sports may be difficult for children with ASD, exercise and social involvement are important for their psychological and physical health.

Sowa and Meulenbroek's (2012) meta-analysis compared studies that used group-based or individual-based interventions aimed to increase the physical exercise for children and adults with ASD. The researchers compared the effects of these on the participant's communication, social, and motor skills within each study. The results were determined to be insufficient to systematically evaluate communication skills; however, the results for motor skills confirmed the researchers' hypothesis that individual-based exercise programs were more effective than group-based exercise programs. Contrary to the researchers' hypothesis, individual-based interventions had a greater effect on social skills than the group-based interventions. However, Sowa and Meulenbroek found that the results on social interactions during group interventions were not always clear as to whether the interactions were between the participants with ASD and their teammates or with staff members. Sowa and Meulenbroek have suggested that future research needs to describe the social interactions more clearly for accurate analysis. When assessing social skills for children with ASD, it is important to measure their interactions with peers so that the results are meaningful beyond the

study. One sport that may be a viable option for children with ASD to interact with their typically developing peers is indoor rock climbing.

Indoor Rock Climbing Basics

Indoor rock climbing may be a good option for children with ASD to be physically active, and to socialize with typically developing peers, due to the sport's physical and social nature. Compared to team sports, the rules and goals of rock climbing are simple. The goal of indoor rock climbing is to follow a designated route and to climb to the top of the wall. The rules of indoor rock climbing are to follow all of the necessary safety precautions. When first learning to climb, an experienced climber can help teach the safety precautions of rock climbing and serve as a belayer so that no climbing attempt is unsafe. Novice climbers also have the benefit of being able to learn the component skills of rock climbing because of how the learning opportunities are presented. Since all climbing routes are rated according to their difficult, novice climbers are able to start on easier routes and as their rock climbing muscles and technique develops, they are able to advance to more difficult routes. This is advantageous when climbing in groups since there are many routes for each person to attempt. This allows each climber to progress at their own pace while still being able to climb with a more or less experienced climber. For an individual with ASD, this may crucial since their performance will not hinder a peer's performance while climbing. As routes get more difficult the type of climbing moves become more complex. Since the holds on an indoor climbing wall are always stationary, one can practice a climbing move multiple times. There is also no time limit when learning a climbing move; unlike the transient aspect of many team sports (e.g. dribbling a basketball or catching a ball) the wall and relevant holds are constantly

available. Although indoor rock climbing is an individual sport, there are still social components to it.

One social component to rock climbing deals with the issue of safety when top roping. Top roping is a form of climbing that involves a climber and an individual who is in charge of their safety known as the belayer. The climber and belayer are secured into harnesses. The climbing rope is attached to each person's harness and to an anchor system at the top of the wall. The belayer always remains on the floor and it is his or her job to stop the climber from falling to the ground, allowing the climber to come down slowly when they are done climbing, and to hold the rope so the climber can stay on the wall to rest. Another social aspect between the climber and belayer is that the belayer is able to provide advice, direction, or encouragement to the climber. This is especially true if the belayer has finished a route that the climber is working on because the belayer may be able to tell the climber to use a particular hold or execute a technique that was successful for them. These types of interactions are seen at climbing gyms before, during, or after a climber attempts a route. If the safety and success of one person's climbing is reinforcing to the other climbing partner, an interdependent group contingency is demonstrated, and this is often inherent in the sport of rock climbing.

Interdependent group contingencies are "contingencies in which reinforcement for all members of the group is dependent on each member of the group meeting a performance criterion that is in effect for all members of the group" (Cooper, Heron, & Heward, 2007, p. 569). In regards to safely climbing when top roping, the contingency for reinforcement is demonstrated if both the climber and belayer successfully complete all the requirements necessary, the climber and belayer will avoid injury from falling. Additionally, an interdependent

group contingency is seen when two climbing partners help each other by providing instructions or demonstrations of how to execute a specific climbing move that then leads to both climbers becoming more skilled and being able to finish more difficult climbing routes. If the success of a climbing partner isn't reinforcing to the person giving advice, a contrived interdependent contingency can be implemented to support the interactions, providing conditioned reinforcers to each climber only when both climbers meet specific climbing goals. Contrived interdependent group contingencies have shown to be effective for promoting social interactions between members in a group in a variety of contexts. For example, Gresham and Gresham (1982) implemented this type of group contingency for managing classroom behaviors, and results suggest that this led to more group cooperation and peer-to-peer reinforcement. This type of group contingency has also been shown to increase physical activity for school-aged children. Kuhl, Rudrud, Witts, and Schulze (2015) tested the effects of two interdependent group contingencies (individual vs. cumulative classroom goal setting) on physical activity in a third grade class. The researchers found that the individuals in the class increased the number of steps taken during both interdependent group contingencies, but that using individual goal setting was even more effective. Additionally, anecdotal information obtained by school personnel indicated that classmates provided more peer encouragement and support regarding their step-count progress, during the study.

Interdependent group-oriented contingences were implemented in the current study for meeting climbing goals, because this type of contingency mimics the naturally occurring contingencies of rock climbing and because this type of contingency has shown to increase peer interaction (Gresham & Gresham, 1982). The primary purpose of the current study was to measure the effects of an

interdependent group-oriented contingency on the social interactions between adolescents diagnosed with ASD and their typically developing peers while rock climbing at an indoor gym. The secondary purpose of the study was to measure the participants' motor proficiency at the onset and completion of the study.

CHAPTER 3: METHODS

Participants and Setting

Three males with a primary diagnosis of Autism Spectrum Disorder (ASD)—Troy (12 years 3 months), Steve (13 years 10 months), and Dante (12 years 1 month)—were the participants in the study. Six individuals with no diagnosis of ASD or other intellectual disabilities served as peers in this study. Troy's peers were Michael (10 years 8 months) and Mia (12 years 2 months). Troy and Michael had no indoor rock climbing experience while Mia had some experience prior to the study. Steve's peers were Jerry (12 years 6 months) and Jessica (14 years 1 month). Steve, Jerry, and Jessica had no indoor rock climbing experience prior to the study. Dante's peers were Randy (11 years 1 month) and Amari (13 years). Dante, Randy, and Amari had some indoor rock climbing experience prior to the study. The participants and peers climbed in dyads and only one dyad climbed at the gym at a time. All of the participants and peers were able to label primary and secondary colors, follow a variety of 2-step instructions, discriminate between their left and right, and had no medical issues that prevented them from rock climbing. The participants' and peers' parents or guardians filled out consent forms that discussed the purpose of the study, potential risks, and potential benefits for their child or dependent participating in the study (see Appendix A). Additionally, the participants and peers completed assent forms which explained the purpose of the study, their right to stop participating, and that they would earn points that they could exchange for prizes (see Appendix B). The parents or guardians also completed a PAR-Q (Canadian Society for Exercise and Philosophy, 2011) to determine the child or dependent's readiness to engage in physical activity (see Appendix C). The exclusion criteria for this study was if the

participant or peer engaged in physical aggression, eloped from the climbing gym, or refused to participate in any three sessions. None of the participants or peers met these criteria during the study. The study took place at a climbing and fitness gym in the local area. Parents or caregivers signed all liability waivers supplied by the climbing gym for their child or dependent to participate.

Materials

Climbing Gym and Equipment

The climbing gym contains 12,000 square feet of climbing terrain and 80 top and lead ropes. The participants were exposed to the method of climbing known as top roping, Top roping routes at the climbing gym are 42 feet high and vary in degree of difficulty according the Yosemite Decimal System. The holds on the wall are made from polyurethane molds that vary in shape and color and each route at the gym contains holds that are one solid color. Top roping involves a climber and an individual who is in charge of their safety known as the *belayer*. Research assistants belayed for each participant and peer in the study and were overseen by a second certified belayer. Belayers were required to pass the climbing gym's belay test and wear their belay card whenever they are belaying. The climber and belayer were required to wear harnesses when top roping. Climbing shoes and climbing chalk were available to each participant throughout the study.

Route Levels

The two easiest routes at the gym were located next to each other on a single wall and are rated 5.5 and 5.6. During the rappelling phase of the study, the participant and peer learned the proper rappelling technique on these two routes.

The research assistant instructed the climbers that they can use holds on both routes to reach the target height. After the participant or peer passed the rappelling phase of the study, the research assistant instructed the climber to follow a specific route before each attempt. During the baseline and the interdependent group-oriented contingency phases of the study the routes that the participant and peer were allowed to climb were determined by their climbing success. The initial route options for the participant and peer were on routes 5.5 and 5.6. Once the participant or peer reached the top of route 5.6 without making a route following error, they were given the option to climb routes rated from 5.5 to 5.9. After the climbers passed a 5.9 rated route, the most difficult route they were allowed to climb was rated 5.10a. At the climbing gym, routes that are rated 5.10 or higher have a subgrade designated by the letters a, b, c, or d. The subgrades range in difficulty with the subgrade "a" being the easiest and "d" being the most difficult. For example, a route rated 5.10a is easier than a route rated 5.10b, and a route rated 5.10.b is easier than a route rated 5.10c. Once the participant or peer passed a route with a specific subgrade they were allowed to attempt a route with one subgrade higher.

Experimental Design

A nonconcurrent multiple-baseline-design-across participants, with a reversal, was used. Each participant was exposed to the following conditions: baseline (including rappelling), interdependent group-oriented contingency, and a return to baseline with a novel peer.

Dependent Variable and Data Collection

Social Interactions

Social interactions between the participant and peer were video recorded by a research assistant using an action camera. The videos were later coded by type of social interaction and measured as rate per minute. Trained research assistants scored the social interactions similarly to Speltz, Shimamura, and McReynolds (1982) as being positive, negative, or neutral (see Appendix D). Separate instances of social interactions were counted whenever there was a 3-second break in social interactions. A data sheet was used to track social interactions throughout the climbing portion of each session (see Appendix E). The observation period for social interactions took place while the participant or peer were climbing and during any time between climbing attempts. Data collection on social interactions started after the participant and peer were wearing their harnesses and the research assistant told the dyad they could start climbing. Data collection ended once the participant or peer untied from their safety rope following their dyad's final climbing attempt of the session. Social interactions were not recorded during the warm up and cool down exercises, nor whenever the participant or peer did any of the following behavior: using the restroom, leaving their climbing partner to the water fountain to drink water, or interacting with the staff at the gym's front desk to get a snack or climbing gear. A separate data sheet was used to track social interactions made by the participant while their peer was climbing or rappelling back down to the ground (see Appendix F). This observational period started once both feet were off the ground and it ended once their feet returned to the ground.

Decisions about the participant's progression through the phases of the study were made by examining each participant's rate of positive, negative, and neutral interactions, and participants advanced when these had reached relative

stability. Positive and neutral interactions were combined and analyzed because both of these types of interactions were functionally appropriate during sessions, and because on some sessions there was a possibility of an inverse relationship between them. For instance, if the participant and peer started and maintained a conversation that was coded as having multiple neutral interactions, their rate of positive interactions may have decreased due to time being spent during the neutral conversation topic and vice versa.

Bruininks-Oseretsky Test of Motor Proficiency, Second Edition (BOT-2™)

A registered, licensed Occupational Therapist (OTR/L) administered the Bruininks-Oseretsky Test of Motor Proficiency, second edition (BOT-2™) at the onset and at the completion of the study to measure the participant's motor skills. The BOT-2™ is a normative test that contains eight subtests of fine and gross motor abilities including fine motor precision, fine motor integration, manual dexterity, bilateral coordination, balance, running speed and agility, upper-limb coordination, and strength. The scores from these 8 subtests are used to make up composite scores in four motor areas and one comprehensive measure of overall motor proficiency. The composite scores for the four motor areas include fine manual control, manual coordination, body coordination, and strength and agility (Bruininks, 2005). The results of the subtest were converted to scale scores that are adjusted to the individual age and gender. The results on the composite scores were converted to a standard score that corresponded to a percentile rank. This percentile rank is compared to a gender norm sample. Each of the participant's motor proficiency was individually analyzed by comparing their pretest and

posttest data for the eight subtests, four composite scores, and their total motor composite score.

Climbing

During each climbing attempt research assistants collected data on the following: the rating level of the route, the highest point climbed without the assistance of the climbing rope, the highest point climbed after the climber received assistance from the climbing rope, the duration of each climb, and the number of incorrect holds used per attempt. The highest point climbed per attempt was measured in feet from the ground to the highest hold that the participant touched with their hand. To determine the highest point climbed per attempt, the research assistant noted which hold the climber grabbed on a data sheet (see Appendix H) which was later measured after the session. To determine the duration of each climbing attempt the research assistant started a stopwatch once all four points of contact, two feet and two hands, were off the ground and on the wall. If the participant reached the top of the route, the research assistant stopped the stopwatch. If the participant fell and did not attempt to climb higher within 30 seconds or if the participant asked to come down, the duration of the climb ended. A route following error was defined as the climber grabbing or stepping on a hold that did not belong to the route that the climber was started on. The research assistant used a counter to track the number of incorrect holds during each climbing attempt.

Interobserver Agreement

Interobserver agreement (IOA) on social interactions was collected for 36% of the sessions. The first author and secondary observer simultaneously tracked the instances and type of interactions made by the participant and peer during IOA

sessions. The two observers resolved disagreements about the occurrence and type of interaction that took place by replaying the video and discussing why an interaction was coded as positive, negative, or neutral. Any instance that was resolved was not counted as a disagreement, but any instance not resolved was still counted as a disagreement. Interobserver agreement was calculated by dividing agreements by agreements plus disagreements and multiplying by 100%. The mean IOA agreement was 99.7% (range 99.5%-100%).

Independent Variable and Procedural Integrity

The independent variable in this study was the use of an interdependent group-oriented contingency for meeting climbing goals. Throughout the study, the participant and peer took turns climbing. During the interdependent group-oriented contingency phase, the participant and peer both earned one point whenever they met their individual climbing goal and their climbing partner met their individual climbing goal on their previous climbing attempt. If the participant or peer met their climbing goal and then their climbing partner did not meet their climbing goal, neither the participant nor peer earned a point. If a session ended with the participant or peer meeting their climbing goal, the participant or peer who was watching had the opportunity to climb first on the subsequent session and earn their group a point if they met their climbing goal. The research assistants used a data sheet (see Appendix H) to take data on the participant and peer's climbing attempts to help correctly deliver and track the participant and peer's points. These points were later exchanged for preferred items.

To ensure procedural integrity, the first author and a research assistant reviewed the climber's performance for each climbing attempt. Prior to all sessions in the interdependent group-oriented contingency phase, each of the

participant and peer's climbing goals were reviewed by the first author and a research assistant. During procedural integrity sessions, a research assistant reviewed videos of the sessions to record accuracy data on the correct implementation of the interdependent group-oriented contingency. The research assistant collected data on (a) if the first author stated the correct climbing goal to the participant and peer prior to the climber starting their route, (b) if the first author told the participant and peer whether or not the climber achieved their goal once he or she returned to the ground, and (c) if the first author told the participant and peer that their dyad did or did not earn a point as a result of the climber's performance and how it related to the interdependent group-oriented contingency. This occurred for 36% of sessions and procedural integrity was 100%.

Procedure

General Procedures

Each session included one dyad (one child diagnosed with ASD and one typically developing peer) and two to three research assistants. The total number of sessions, the duration of participation of the study, and the rate of the sessions per week varied for each participant. Troy participated in 18 sessions over the span of 35 weeks with a range of 0-3 sessions per week. Steve participated in 24 sessions over the span of 32 weeks with a range of 0-3 sessions per week. Dante participated in 19 sessions over the span of 52 weeks with a range of 0-2 sessions per week. Each session lasted 60-90 minutes and consisted of the following: 10 minutes of warm-up exercises (see Appendix G), 45-60 minutes of climbing, 10 minutes of cool down exercises (see Appendix G), and 10-15 min at the end of the session for the participant and peer to eat snacks. Participants and peers were required to take a 5-min break in between each climbing attempt and water was

freely available throughout each session. Prior to the participant or peer climbing a route, the belayer and a second certified belayer completed all safety checks for the climber. The participant and peer took turns climbing while the first research assistant belayed. While the participant or peer were climbing, a second research assistant used a data sheet and stop watch to take data on the climber's attempt (see Appendix H). The participant or peer who was not climbing was instructed to stay with the group until the other participant or peer had completed their climbing attempt. A third research assistant video recorded each session to capture social interactions with the use of an action camera and microphone. These interactions were captured while the participant and peer were climbing and while taking breaks in between climbing attempts. The warm up and cool down exercises were not video recorded throughout the study.

Preference Assessment

A Multiple Stimulus Without Replacement (MSWO) preference assessment, developed by DeLeon and Iwata (1996), was used to identify potential reinforcers for each participant's and peer's climbing behavior and compliance behavior during the study. A research assistant explained to the participant and peer that they were going to choose prizes that they could earn for participating in the sessions and for meeting their climbing goals. At the onset of the study, the research assistant presented 20 objects to the participant and peer separately. If the participant or peer selected an object within 10 seconds, it was set to the side. This process was repeated until all objects were chosen. The potential reinforcers for each participant and peer were ranked according to when they were picked. The items picked first were scored as the most preferred and items picked last being least preferred. The most preferred item the participant or peer picked could be

exchanged for 20 points and each item picked after the first item cost 2 points less. After the participant and peer did the cool down exercises and prior to the snack time, they were given the option to save or exchange their points for preferred items.

Baseline

During the initial baseline sessions, all of the participants and peers, except Mia and Amari, practiced rappelling on the 2 easiest rated routes at the gym, route levels 5.5 and 5.6. Mia and Amari did not practice rappelling because they had recent experience climbing at the gym and demonstrated mastery for rappelling. The goal for practicing rappelling was to teach the proper rappelling technique and to assess their fear response on the wall as they climb higher. The initial height goal was 4 feet high. Subsequent goals were set at heights of 12, 24, and 36 feet on the wall. The research assistant indicated how high to climb by climbing to the climber's goal and taping a 3"x 5" index card to the wall. The research assistants were always properly tied in with a certified belayer when climbing to the height goal to tape the index card on the wall. Once the goal was set, the participant or peer was given the opportunity to climb. The research assistant instructed the participant or peer to climb to the goal by using any hold and touch the index card, stop, let go of the wall, and rappel down. During this phase of the study, the participant or peer were not instructed to follow a specific route and that they could use any hold regardless of its color. Correct responses were counted if the participant reached the height goal and let go of the climbing holds within 10 seconds of touching the index card. While the belayer lowered the participant, he or she must have remained in the proper rappelling position by having their knees bent and legs kicking against the wall. The participant also needed to show zero

signs of distress during the trial to earn a point and to move to a higher goal. Signs of distress were defined as: crying, yelling, or making comments about being scared. If the participant engaged in a correct response, they earned one point. If the participant responded correctly for two consecutive attempts, the height goal was raised. Each participant took turns trying to reach his or her goal. The rappelling phase of the study ended for each participant once they successfully climbed to and rappelled correctly from 36 feet high off the ground. Troy's rappelling mastery criteria was changed from 36 feet to 24 feet because he consistently showed fatigue at the 24-foot mark with zero signs of distress.

After a participant or peer showed mastery for rappelling, baseline data on their climbing ability was taken to determine their climbing goals during the interdependent group-oriented contingency. Baseline data was not collected for Troy, instead his climbing goals were determined by his performance during rappelling. Prior to each climbing attempt the research assistant told the participant to climb a specific route. During baseline, the research assistants did not give advice or feedback to the participant and peer nor did they tell the participant or peer to give advice or feedback to the climber. If the participant or peer initiated a conversation with a research assistant, the research assistant replied by saying that they couldn't talk or to only talk to their climbing partner, unless the participant or peer asked a question about rock climbing safety or which routes they were allowed to climb. If the participant or peer asked to come down to the ground while they were climbing, the belayer asked the climber, "are you sure you don't want to take a break and keep going?" The research assistant let the climber come down if the climber didn't continue to climb after 10 seconds or if the climber said they wanted to come down for a second time. To reinforce compliance behavior, the participant and peer earned a point at the end of the session by completing the

warm up exercises, attempting to climb, and completing the cool down exercises. No points were delivered contingent on social interactions of any kind.

Interdependent Group-Oriented Contingency

The interdependent group-oriented contingency began when the participant showed a relatively steady state of responding for the combined rate of positive and neutral interactions with their peer. Following the warm up exercises during sessions, a research assistant explained the rules of the contingency and modeled how to help a climbing partner while another research assistant climbed. This model included the research assistant providing climbing advice and praise to the research assistant who was climbing. Prior to each climbing attempt, a research assistant climbed to the participant or peer's goal and taped an index card on the wall to indicate the location of their goal. The location of the index card was placed directly above one hold higher than the highest hold that the climber reached on that specific route. Once the climber made it to the top of a specific route, the goal for that route was to reach the top in less time than their personal best. The research assistants then interacted with the participant and peer in the same manner as in baseline with the exception of the following: telling the participant and peer their goal prior to a climbing attempt, whether or not they achieved their goal when they returned to the ground, and whether or not their dyad earned a point according to the rules of the contingency.

Return to Baseline with a New Peer

Following the interdependent group-oriented contingency phase of the study, the participants climbed with a new peer without any contrived reinforcement contingency implemented by the research assistants. This phase of

the study was run identically to the original baseline with the only difference being that the participant's route options continued from the previous phase and the new peer's route options were determined by their previous experience indoor rock climbing. Mia, Troy's novel peer, and Amari, Dante's new peer, began climbing a 5.7 rated route because they had completed a 5.7 rated route outside of sessions. Jessica, Steve's new peer, began in the rappelling stage of the study on the 5.5 and 5.6 rated routes because it was her first time rock climbing indoors.

CHAPTER 4: RESULTS

Social Interactions

Figure 1 depicts the participant's positive, neutral, and negative social interactions with their typically developing peer during the climbing portion of each session. The observational period for Figure 2 was identical to Figure 1; however, Figure 2 depicts the combined rate of positive and neutral interactions. Figure 3 depicts the positive, neutral, and negative interactions made by the participant while their peer was climbing or rappelling back down to the ground. Figure 3 does not depict social interactions that occurred while the participant was climbing or during the time in between climbing attempts.

All of the participants increased their rate of positive interactions during the interdependent group-oriented contingency phase of the study compared to baseline (see Figures 4-6). This increase was seen during the whole climbing portion of each session (see Figure 1) and while the participant was observing their partner climb and rappel (see Figure 3). In addition to positive interactions increasing, the combined rate of positive and neutral interactions increased during the intervention compared to baseline. No negative interactions were observed from Troy, Steve, or their peers throughout the study. A small number of negative interactions were observed from Dante and his peer for 4 out of 12 sessions during baseline. No negative interactions were observed from Dante or his peer during the interdependent group-oriented contingency nor were any negative interactions observed from Dante and his novel peer during the return to baseline phase of the study.

During baseline, Troy's positive and neutral interactions were stable and at low levels with the exception of the second session for positive interactions and

during the fifth session for neutral interactions. When the interdependent group-oriented contingency was introduced, Troy's positive interactions showed an increasing trend. Figure 3 shows that this increase only happened during sessions 14 and 15 while his peer was climbing and rappelling. Troy's neutral interactions drastically increased during the first session of the interdependent group-oriented contingency; however, they showed a decreasing trend. During the return to baseline, Troy began climbing with a novel peer and both positive and neutral interactions returned to low levels. Figure 2 demonstrates that the combined rate of Troy's positive and neutral interactions was similar in level to his peer for 14 out of the 18 sessions.

During baseline, Steve's positive and neutral interactions were stable. During these sessions, the level of neutral interactions was slightly higher than the positive interactions. When the interdependent group-oriented contingency was introduced, Steve's positive interactions considerably increased for the first session (session 11) followed by 4 sessions in which the positive interactions were stable and moderately higher than baseline. During the final three sessions of the interdependent group-oriented contingency phase, Steve's positive interactions increased significantly. Figure 3 and Figure 1 display similar trends of positive interactions, which shows that Steve's positive interactions occurred while his climbing partner was climbing and rappelling. Steve's neutral interactions moderately increased during the interdependent group-oriented contingency phase. When the interdependent group-oriented contingency was removed and Steve began climbing with a novel peer, his positive interactions steadily decreased while his neutral interactions decreased to similar rates as the original baseline condition with the exception of session 22. The combined rate of Steve's positive

and neutral interactions was similar in level to his peer for 17 out of the 24 sessions.

Dante's positive and neutral interactions were variable throughout the study. During baseline, his neutral interactions were at a higher level than his positive interactions for 10 out of 12 sessions. When the interdependent group-oriented contingency was introduced, Dante's positive interactions drastically increased and his neutral interactions were similar to his highest levels as in baseline. Figure 3 and Figure 1 display similar trends of positive interactions, which shows that Dante's positive interactions occurred while his climbing partner was climbing and rappelling. When the interdependent group-oriented contingency was removed and Dante began climbing with a novel peer, his positive and negative interactions steadily decreased. The combined rate of Dante's positive and neutral interactions was similar in level to his peer for 16 out of the 19 sessions.

Motor Proficiency

The participant's pretest and posttest scores on the BOT-2™ are depicted in Tables 1-6. The Occupational Therapist who administered the BOT-2™ predicted that the participants would show the greatest improvements in bilateral coordination, strength, and balance as a result from rock climbing. Overall, all three participants improved their total motor composite scores; however, there were some fluctuations for the eight subtests.

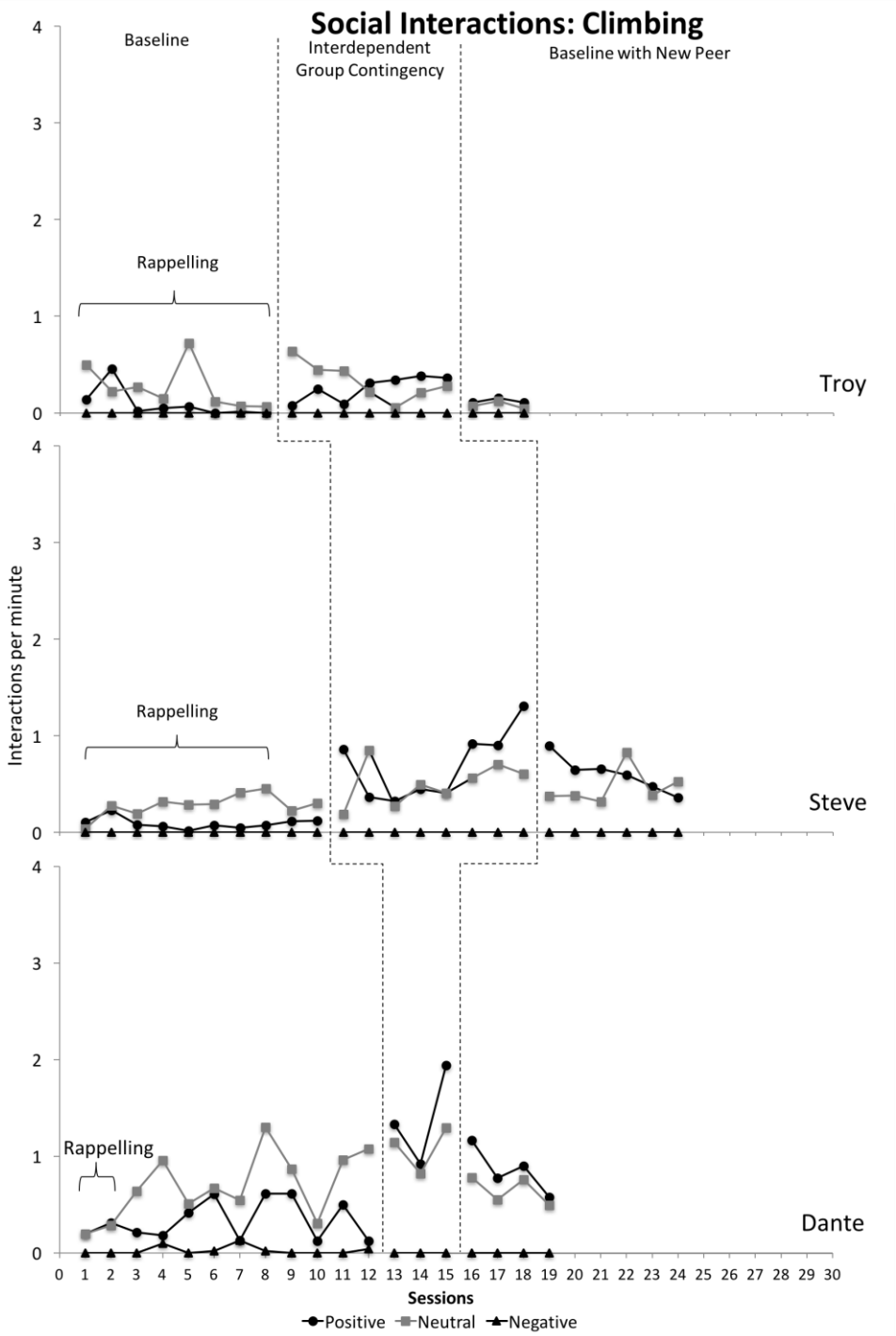

Figure 1. Positive, neutral, and negative interactions made by the participants

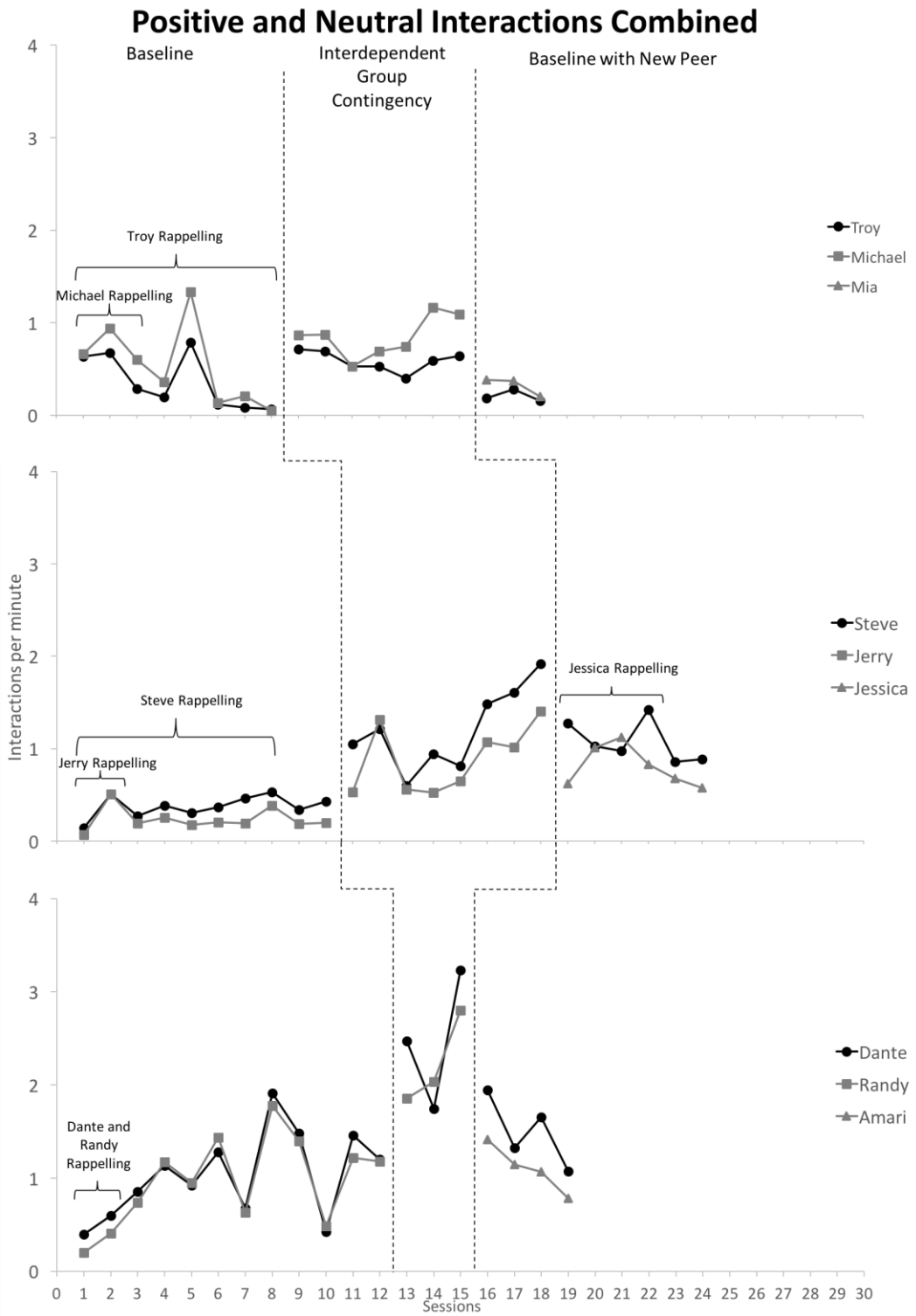

Figure 2. Positive and neutral interactions combined by group

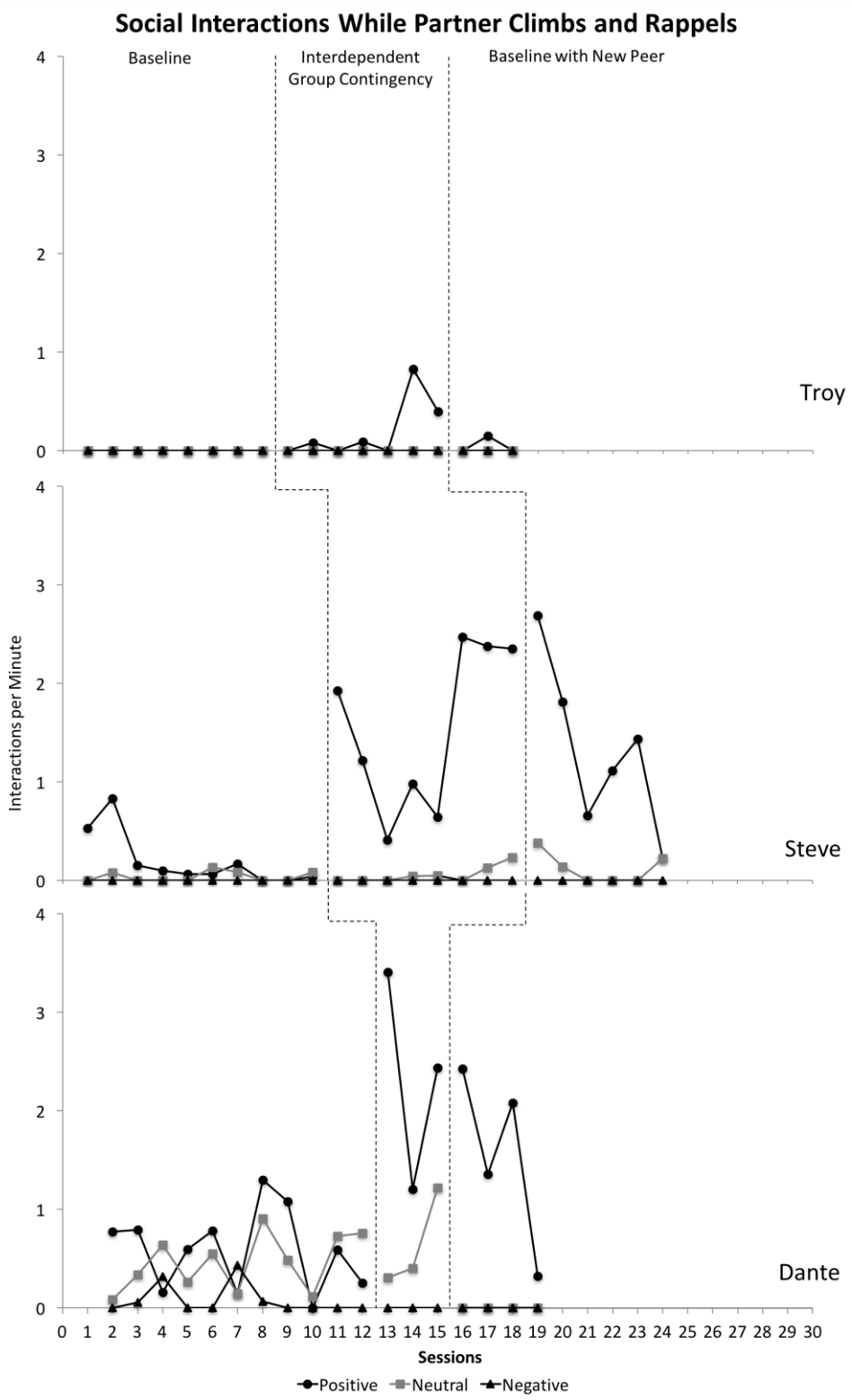

Figure 3. Social interactions while peer was climbing and rappelling

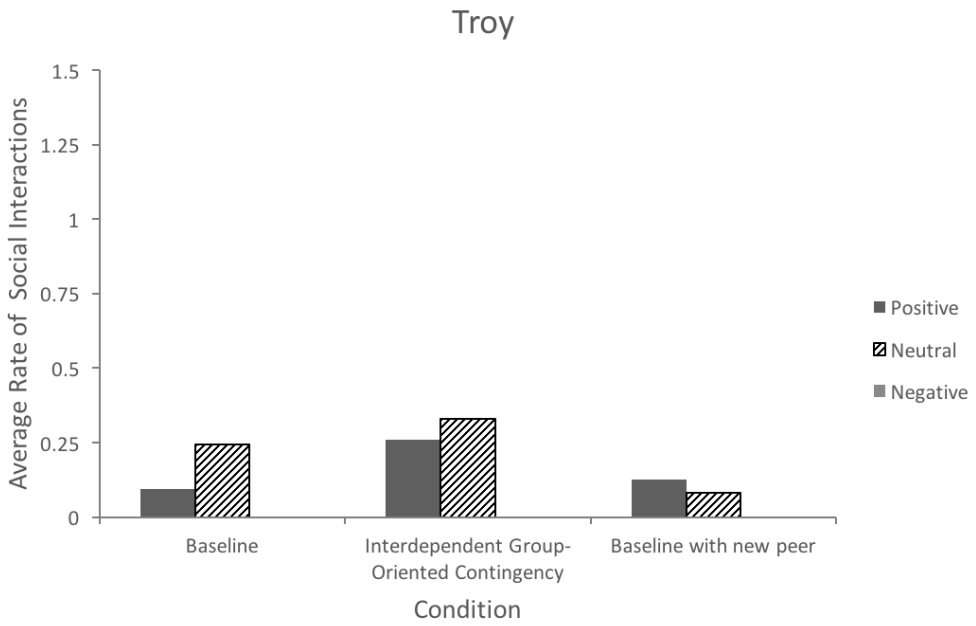

Figure 4. Troy's mean number of interactions per phase

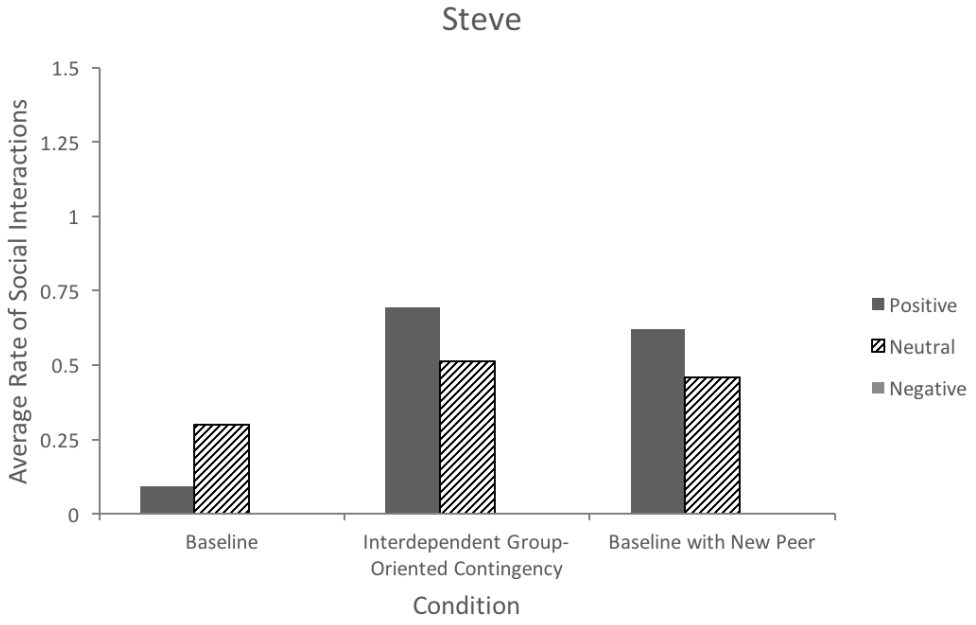

Figure 5. Steve's mean number of interactions per phase

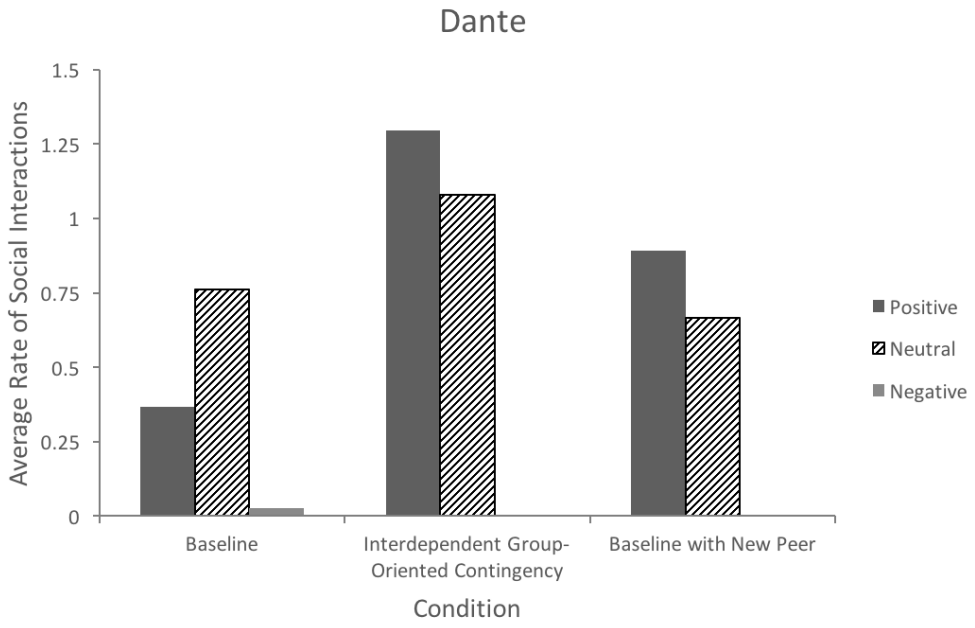

Figure 6. Dante's mean number of interactions per phase

Table 1

Troy's BOT-2™ Subtest Scores

	Pretest 1/29/17		Posttest 10/8/17	
Subtest	Scale Score	Descriptive Category	Scale Score	Descriptive Category
Fine Motor Precision	14	Avg.	11	Avg.
Fine Motor Integration	15	Avg.	22	Above Avg.
Manual Dexterity	16	Avg.	13	Avg.
Upper-Limb Coordination	9	Below Avg.	15	Avg.
Bilateral Coordination	15	Avg.	15	Avg.
Balance	15	Avg.	17	Avg.
Running Speed and Agility	10	Below Avg.	9	Below Avg.
Strength	9	Below Avg.	15	Avg.

Table 2

Troy's BOT-2™ Composite Scores

	Pretest 1/29/17		Posttest 10/8/17	
Composite Score	%tile Rank	Descriptive Category	%tile Rank	Descriptive Category
Fine Motor Control	42%	Avg.	62%	Avg.
Manual Coordination	24%	Avg.	35%	Avg.
Body Coordination	46%	Avg.	58%	Avg.
Strength and Agility	40%	Avg.	27%	Avg.
Total Motor Composite	18%	Avg.	38%	Avg.

Table 3

Steve's BOT-2™ Subtest Scores

	Pretest 9/24/16		Posttest 8/5/17	
Subtest	Scale Score	Descriptive Category	Scale Score	Descriptive Category
Fine Motor Precision	8	Below Avg.	10	Below Avg.
Fine Motor Integration	9	Below Avg.	12	Avg.
Manual Dexterity	8	Below Avg.	13	Avg.
Upper-Limb Coordination	12	Avg.	13	Avg.
Bilateral Coordination	7	Below Avg.	14	Avg.
Balance	12	Avg.	9	Below Avg.
Running Speed and Agility	11	Below Avg.	8	Below Avg.
Strength	5	Well-Below Avg.	6	Well-Below Avg.

Table 4

Steve's BOT-2™ Composite Scores

	Pretest 9/24/16		Posttest 8/5/17	
Composite Score	%tile Rank	Descriptive Category	%tile Rank	Descriptive Category
Fine Motor Control	8%	Below Avg.	16%	Below Avg.
Manual Coordination	12%	Below Avg.	27%	Avg.
Body Coordination	8%	Below Avg.	14%	Below Avg.
Strength and Agility	10%	Below Avg.	7%	Below Avg.
Total Motor Composite	7%	Below Avg.	8%	Below Avg.

Table 5

Dante's BOT-2™ Subtest Scores

	Pretest 9/24/16		Posttest 10/8/17	
Subtest	Scale Score	Descriptive Category	Scale Score	Descriptive Category
Fine Motor Precision	9	Below Avg.	17	Avg.
Fine Motor Integration	15	Avg.	14	Avg.
Manual Dexterity	14	Avg.	11	Avg.
Upper-Limb Coordination	9	Below Avg.	8	Below Avg.
Bilateral Coordination	10	Below Avg.	14	Avg.
Balance	8	Below Avg.	9	Below Avg.
Running Speed and Agility	5	Well-Below Avg.	6	Below Avg.
Strength	7	Below Avg.	7	Below Avg.

Table 6

Dante's BOT-2™ Composite Scores

	Pretest 9/24/16		Posttest 10/8/17	
Composite Score	%tile Rank	Descriptive Category	%tile Rank	Descriptive Category
Fine Motor Control	21%	Avg.	50%	Avg.
Manual Coordination	18%	Avg.	10%	Below Avg.
Body Coordination	7%	Below Avg.	14%	Below Avg.
Strength and Agility	5%	Below Avg.	6%	Below Avg.
Total Motor Composite	7%	Below Avg.	12%	Below Avg.

Social Validity

The participants' parents were given social validity questionnaires at the onset and completion of the study. The questionnaire was a 5-point Likert scale containing seven questions (see Appendix I). Results of the parent questionnaires show that all parents either agreed or strongly agreed to all of the questions (see Figure 7. The participants were also given social validity questionnaires on the onset and completion of the study. The participant questionnaires contained six

questions and answers were rated as “yes, no, and I don’t know” (see Appendix J). The responses were scored as the following: “Yes” =2, “I don’t know” =1, and “No” =0. Questions 1-4 were regarding the participant’s feelings about exercise and health, if they liked being involved in the study, and if they liked rock climbing. Questions 5 and 6 assessed whether or not they liked rock climbing with their partner and if they would like to hang out or play sports with them. The results of the participant questionnaire were separated for questions 1-4 (see Figure 8) and questions 5 and 6 (see Figure 9) to show how the participants answers differed for each peer. Troy and Dante’s feelings on questions 1-4 increased from the onset of the study to the completion of the study, while Steve’s score remained the same. Troy’s responses for Michael remained the same from the onset to the completion of the study and they increased for Mia. Steve’s responses for Jerry and Jessica increased from the onset to the completion of the study. Dante’s responses for Randy and Amari remained the same at the onset and completion of the study.

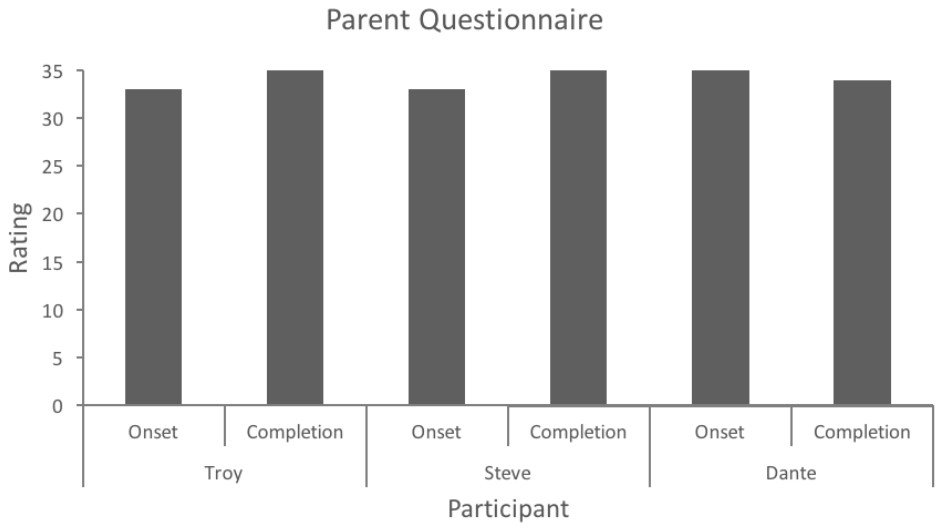

Figure 7. Parent social validity questionnaire results

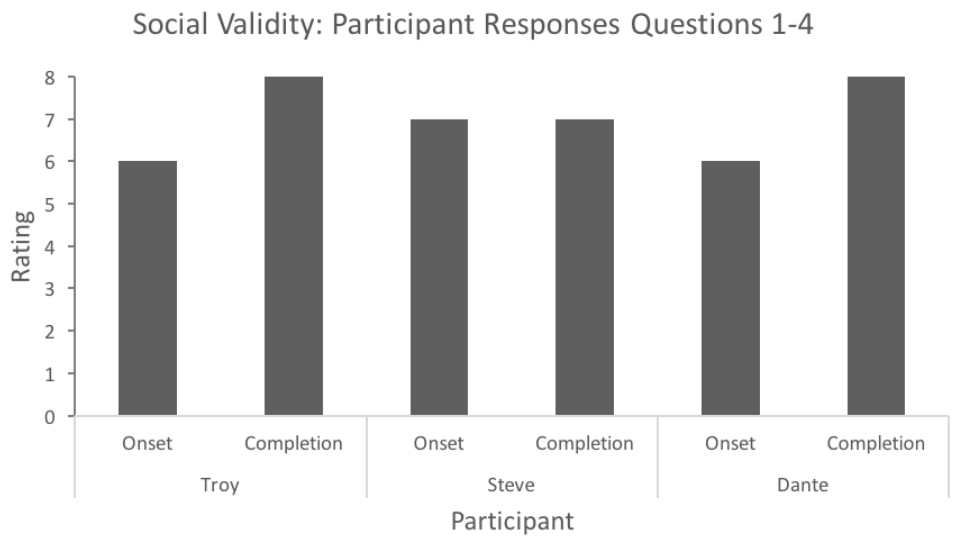

Figure 8. Participant responses to questions 1-4 on the social validity questionnaire

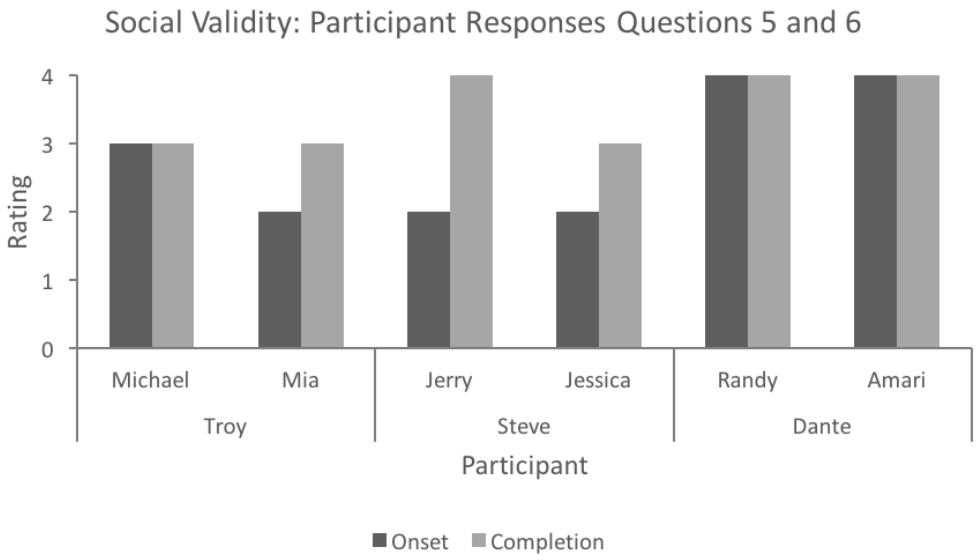

Figure 9: Participant responses to questions 5 and 6 on the social validity questionnaire

CHAPTER 5: DISCUSSION

The results of this study suggest that the interdependent group-oriented contingencies may have promoted positive interactions between the members of each climbing dyad. These results are consistent with past research (Gresham & Gresham, 1982). For all three participants the rate of positive interactions was higher in the interdependent group-oriented contingency phase compared to baseline, and the positive interactions did show a decrease in level and trend for all participants during the return to baseline, indicating that the group contingency was likely responsible for the increase. In a practical sense, we may also say that the increased positive interactions did not maintain or generalize with their new peer in the absence of the interdependent group-oriented contingency, indicating that further multiple exemplar training may be needed to demonstrate sustained and generalized increases. Throughout the study, no negative interactions were observed from Troy, Steve, or their peers. Low levels of negative interactions were observed from Dante and his peer during a few baseline sessions; however, these interactions decreased to zero when the interdependent group-oriented contingency was implemented. Furthermore, the majority of the negative interactions during baseline could be interpreted as being age appropriate and may not have had an overall impact on the participant and peer's relationship. This is, in part, supported by the fact that their positive and neutral interactions remained at higher levels. There is a possibility that the high ratio of adult researchers may have played a role on the participants' and peers' rate of negative interactions.

In addition to the results on social interactions, the BOT-2™ scores provide some support that indoor rock climbing is a good exercise for an individual's motor development. Although the participants' BOT-2™ scores showed a modest

increase for their total motor composite scores, the participants were able to engage in the exercise with their peers regardless of their differences in their athletic abilities. Furthermore, if the participants engaged in rock climbing more frequently during the study, the results on their motor abilities may have been greater.

Limitations and Future Research

One of the challenges of measuring social interactions in public settings is to control for extraneous variables, while maintaining a somewhat naturally occurring social interaction in that setting. In order to minimize the participant and peer interacting with the adult research assistants, social interactions directed toward the research assistants were redirected, excluding questions about climbing safety. This may have been a limitation because at the climbing gym it is very common for adults to provide praise, climbing advice, and to respond to child initiated interactions. One potential solution to this problem for future studies that aim to measure social interactions between peers in the community could be for the researchers to have a set criterion on the number of interactions to respond to. Additionally, reactivity may have occurred as a result of the researcher's use of an action camera and clipboard, especially when the camera was aimed at the participant or peer who was observing their partner climb.

Another potential limitation of this study was that the participants were not allowed to boulder. Bouldering is a type of climbing in which the climber does not use a safety harness and the routes are typically shorter in distance. The participants and peers often requested to climb on bouldering routes but were not allowed due to safety concerns. It is possible that bouldering may provide an increased number of opportunities for socialization compared to top roping, as

bouldering routes are shorter and do not require the climber to tie in to a safety harness, so turn taking can occur more often. This may allow the climber to engage in more positive interactions by teaching a specific climbing move by modeling the move and then allowing the climbing partner to attempt that same climbing move. It is also plausible that watching a climber attempt a boulder route requires less response effort than observing a climber attempt a top roping route. For example, the shorter routes reduce the strain on the observer's neck as well as the necessary speaking volume for the climber to hear because there is less distance between the climber and observer.

Another limitation of the study was that there was no return to the intervention with the new peer. This was primarily due to time limitations and participant/peer availability. Multiple exposures to the intervention with different peers may enhance the likelihood of generalization and maintenance across people and time.

Future research may also incorporate changes to the size of the group. Although some sports only require two individuals to participate, having small groups may provide more opportunities for social interactions. For example, when a group of three people are indoor rock climbing, there can be two people watching the third person climb. This may set up opportunities for the observers to interact with each other or discuss strategies on how to help the climber. Although there is the possibility of negative interactions to occur or the individual diagnosed with ASD to be excluded, interventions like group contingencies may affect positive social interactions among the group.

Another area of future research for involving children diagnosed with ASD and typically developing peers is to directly teach skills specific to the activity to one individual and then at a later time probe whether or not that individual teaches

the other members in the group. For example, a further replication of this study could contain sessions in which a research assistant directly teaches climbing moves to the individual with ASD, then probing whether or not the individual with ASD teaches other members of the group. This type of research could also incorporate the use an interdependent group-oriented contingency if those type of interactions did not occur.

Conclusion

A critical component for teaching social skills to individuals diagnosed with ASD is to provide them with opportunities to socialize with their peers. The results of this study provide support that indoor rock climbing may be one option for this population to engage in exercise while socializing with their peers due to the sport's physical and social characteristics. Additionally, indoor rock climbing is a sport that is available year around that individuals are able to do it well into adulthood. In an applied setting, it may be beneficial for practitioners to change some aspects of climbing sessions to better meet the needs of an individual diagnosed with ASD. For example, allowing an individual with ASD to select their climbing partners may provide opportunities for the individual with ASD to develop friendships outside of the climbing gym. Although individuals with ASD often have deficits in social skills, Behavior Analytic interventions like interdependent group-oriented contingencies may promote social interactions between the members of the group.

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APPENDICES

APPENDIX A: INFORMED CONSENT

Parent Informed Consent Form

Your child is invited to participate in a study conducted by Dr. Marianne Jackson and Geoffrey Browning, in affiliation with California State University, Fresno. The purpose of the current study is to measure social interactions between children with Autism Spectrum Disorder (ASD) and their typically developing peers while rock climbing at an indoor gym. The current study will also measure your child's motor skills at the beginning and end of the study.

This study will occur at a local indoor rock climbing and fitness gym between 1-3 days per week. Each session will last 1 to 2 hours and the entire study will last approximately two to three months. There will be no monetary compensation for participation in the study; however, the primary researcher will cover the cost to climb and rent the safety equipment from the climbing gym. Each session will consist of one child diagnosed with Autism Spectrum Disorder (ASD) and a child without an ASD diagnosis. There will always be at least two adult research assistants present.

During each session your child will first warm up their muscles by engaging in 10 minutes of stretching and light aerobic exercises, such as jogging, riding a stationary bike, jumping jacks, or running in place. After your child finishes the warm up exercises, he or she will take turns climbing with their climbing partner for 45-60 minutes. Some days your child and their climbing partner will have climbing goals. If both partners reach their climbing goals, they will earn points in which they can exchange for small prizes. Your child will be required to take 5-minute breaks in between each climbing attempt to minimize this risk of physical

injury and water will be available during each session. After the 45-60 minutes of climbing, your child and their climbing partner will engage of 10 minutes of stretching and light aerobic exercises to properly cool down their muscles. Your child can choose not to engage in the warm up exercises, rock climbing, or cool down exercises or choose to stop at anytime during the study. There will be a brief survey for you and for your child at the beginning and end of the study.

Any information obtained in this study will remain confidential. Signing this document grants us permission to disclose your child's data in the form of tables and graphs; however, your child's name will be changed so their identity remains confidential. All forms and data will be kept under two separate locks.

This study will not put your children at more risk than they would typically experience at an indoor climbing gym. Indoor rock climbing is inherently dangerous if safety precautions are not taken. Potential risks include injury, paralysis, or death from falling off the wall and making impact with the ground. The method of climbing your child will participate in is known as top roping, which involves a climber and belayer. The belayer is an individual who is in charge of the climber's safety through the use of a climbing rope that is attached to both the climber and belayer's harnesses and an anchor system at the top of the wall. The belayer stays on the ground while the climber is climbing or rappelling and it is his or her job to hold the climbing rope whenever the climber falls or wants to take break. The belayer is also in charge of giving the appropriate amount of slack on the rope while the climber is ascending on the wall. When the climber lets go of the wall, he or she will fall the same distance that there is slack on the rope before the belayer holds the rope. When the belayer holds the rope the

climber will stay on the wall. The belayer should keep minimal to no slack on the rope so that the climber only falls a short distance before the belayer holds him or her on the wall. When the climber is ready to come down, the belayer uses the climbing rope and belay device to lower the climber down to the ground. The use of the climber and belayer's harness, belay device, and anchor system on the wall makes it easy for the belayer to hold the climber's weight. The research assistant will be trained on how to properly belay and will need to pass an official belay test given by a staff member at the climbing gym. At no point during the study will your child be allowed to climb without a certified belayer or be allowed to belay for another individual. Participating in indoor rock climbing also carries the potential risk of physical injury to the climber's hands, feet, joints, and muscles. To minimize the risk of physical injury to their muscles and joints, the participants will engage in 10 minutes of stretching and light aerobic exercises prior to and following climbing sessions. The participants will also be required to take 5-minute breaks in between each climbing attempt and water will be available to them throughout each session. To minimize the risk of physical injury to the participant's feet, each participant will be required to wear properly fitted rock climbing shoes during each climbing attempt. The researcher will cover the cost to rent climbing shoes throughout the study. To minimize the risk of physical injury to the participant's hands, climbing chalk will be available for each climbing attempt and hand lotion will be available to the participants at the end of each session. If a participant suffers an injury during a session they will receive appropriate medical attention and be allowed to stop climbing for the day. To minimize the potential psychological risk of anxiety or distress from being off the ground, each participant will go through the rappelling phase of the study. This phase will focus on teaching proper rappelling technique initially from short

distances. The proper rappelling technique involves the climber keeping their knees bent and legs kicking against the wall while the belayer lowers them to the ground. As the participants show mastery for rappelling without exhibiting signs of distress, the participants will practice from higher distances. To minimize the potential risk of experiencing aversive social interactions with their climbing partner, the research assistants will instruct both participants to speak nicely to each other at the onset of each session.

If the methods successfully show that indoor rock climbing promotes social interactions between children diagnosed with ASD with their peers or if indoor rock climbing promotes the motor development for children with ASD, the results may be shared with schools, physical education classes, or agencies that provide services for children with ASD. Your child may benefit from this study by engaging in physical exercise as well as experiencing positive social interactions with their climbing partner.

You and your child's decision whether or not to participate will not prejudice your future relations with California State University, Fresno or the climbing and fitness gym. If you decide to allow your child to participate, you are free to withdraw your consent and discontinue your child's participation at any time without penalty. The Committee for the Protection of Human Subjects at California State University, Fresno has reviewed and approved the present research.

If you have any questions, please contact us. If you have additional questions in the future, please contact Dr. Marianne Jackson by email

(majackson@csufresno.edu) or by phone (559-278-2757), or Geoffrey Browning by email (gbrowning@mail.fresnostate.edu) or by phone (760-662-1438). Questions regarding the rights of research subjects may be directed to the CSUF Chair of the Committee for the Protection of Human Subjects, Dr. Constance Jones at (559) 278-4468.

You will be given a copy of this form to keep.

YOU ARE MAKING A DECISION WHETHER OR NOT TO HAVE YOUR CHILD PARTICIAPTE IN THIS STUDY. YOUR SIGNATUTE INDICATES THAT YOU HAVE DECIDED TO ALLOW YOUR CHILD TO PARTICIPATE, HAVING READ THE INFORMATION PROVIDED ABOVE.

Name of Child: _____

Name of Parent: _____

Date: _____ Signature: _____

APPENDIX B: STUDENT ASSENT FORM

Student Assent Form

I, _____, have been asked to participate in a research study about children with Autism Spectrum Disorder and typically developing peers participating in indoor rock climbing. Geoffrey Browning, a graduate student from California State University, Fresno explained the study to me. ("Each day you will do rock climb on routes that the researchers instruct you to climb. On some days you will earn points if you and your climbing partner reach your climbing goal. You can use these points to buy toys or play games while you are at the climbing gym during break time. You do not have to participate if you do not want to and you can stop participating in the study at any time and you will not be punished.")

My name will not be given to other people and it will not be written on any reports for this study.

I know that if I have any questions about the research study I can call Geoffrey Browning at (760) 662-1438 or Dr. Marianne Jackson at (559-278-2757). I also know that if I have any questions about my rights, I can call Dr. Constance Jones at (559) 278-4468.

I would like to participate in this study.

_____ _____

Student's Signature Date

APPENDIX C: PAR-Q (CANADIAN SOCIETY FOR EXERCISE AND PHILOSOPHY, 2011)

Completed by a Parent/Guardian of Child

NAME OF CHILD: _____

CHILD'S DATE OF BIRTH: _____ CHILD'S AGE: _____

Please complete the following physical activity readiness questionnaire for your child. All information in this questionnaire will remain confidential.

	Check the appropriate box	
	Yes	**No**
1. Have the procedures of the study been fully explained to you?		
2. Has your doctor ever said that your child has a heart condition and that your child should only do physical activity recommended by a doctor?		
3. Does your child ever experience chest pain during physical activity?		
4. Does your child ever lose balance because of dizziness or do they ever lose consciousness?		
5. Does your child have a bone or joint problem that could be made worse by a change in their physical activity participation?		
6. Does your child have uncontrolled asthma (i.e. asthma that is not easily controlled by an inhaler?		
7. Is your doctor currently prescribing any medication for your child's blood pressure or a heart condition?		
8. Do you know of any other reasons why your child should not undergo physical activity? This might include diabetes, a recent injury, or serious illness.		

If you have answered **YES** to question 1 and **NO** to questions 2-8 then you can be reasonably sure that your child can take part in the physical activity requirement of this project.

I (_____) declare that the above information is correct at the time of completing this questionnaire on date: _____

Parent Signature: _____

Please note: If your child's health changes so that you can answer YES to any of the questions 2-8, notify the investigators and consult with your doctor regarding the level of physical activity that your child can participate in.

If you answered YES to one or more of the questions 2-8:
Talk to your doctor in person discussing with him/her those questions you answered yes.
Ask your doctor if your child is able to participate in the physical activity requirements of
this project.

Doctor's Name: _____ Date: _____

Doctor's Signature: _____

Signature of Investigator _____Date _____

APPENDIX D: DEFINITIONS FOR SOCIAL INTERACTIONS

Definitions for Peer interactions

Positive interactions

1. Verbalizations or gestures of friendship, concern, congratulations, gratitude, or encouragement (e.g. compliments, cheering, handshaking, back patting).
2. Requests or offers for assistance or instruction, or gestures apparently for assistance.

Negative interactions

1. Name calling or swearing at a peer.
2. Laughing at a peer's mistake.
3. Threats of physical aggression.
4. Physical aggression (e.g. hitting, slapping, biting, pushing, rough/forceful back slapping).
5. Obscene gestures, gestures of disgust or disapproval, gestures intended apparently to antagonize or frighten a peer.
6. Behaviors that prevent or interfere with a peer's leisure activity.

Neutral interactions

1. General discussion or nonnegative comments directed to a peer (e.g. statements or questions such as "Look at this;" "What are you doing?").
2. Non-directed verbalizations intended apparently to evoke a verbal or nonverbal response from a peer (e.g. "This is hard!" "I'm down.").

APPENDIX E: SOCIAL INTERACTIONS DATA SHEET

Date:	Date coded:	RA initials coding video:
Circle one: Original Data or IOA		

Climbing duration:

Participant:					Peer:				
Participant Snack Duration:					Peer Snack Duration:				
Comments: Questions: Responses:					Comments: Questions: Responses:				

Conversational Units:

APPENDIX F: SOCIAL INTERACTIONS WHILE OBSERVING DATA SHEET

Observer: Climber:		Route: Duration:	
Positive help	Positive praise	Neutral	Negative
Observer: Climber:		Route: Duration:	
Positive help	Positive praise	Neutral	Negative
Observer: Climber:		Route: Duration:	
Positive help	Positive praise	Neutral	Negative
Observer: Climber:		Route: Duration:	
Positive help	Positive praise	Neutral	Negative

Participant's duration routes watched (sec): _____= _____ Help: __ + Praise: ___= Positive__ Neutral __ Negative __	Peer's duration routes watched (sec): _____= _____ Help: __ + Praise: ___= Positive__ Neutral __ Negative __

APPENDIX G: WARM UP AND COOL DOWN EXERCISES

Warm up and Cool down exercises:

- Jogging on a treadmill
- Riding a stationary bike
- Jumping jacks
- Rowing Machine
- Running in place

APPENDIX H: CLIMBING DATA SHEET

Date: Participant initials: Peer initials:						
Circle one	Route Rating and Name	Highest point without assistance from rope	Highest point after assistance from rope	Duration of climb	Incorrect holds	Goal Met yes or no?
Participant or Peer						
Participant or Peer						
Participant or Peer						
Participant or Peer						
Participant or Peer						
Participant or Peer						
Participant or Peer						
Participant or Peer						

APPENDIX I: PARENT SOCIAL VALIDITY QUESTIONNAIRE

Social Validity Questionnaire - Parents

Child initials: _____ Parent initials and relation: _____

1 – strongly disagree
2 – disagree
3 – neither disagree or agree
4 – agree
5 – strongly agree

1. Children should engage in physical activity daily.

   1 2 3 4 5

2. Indoor rock climbing is a good exercise for children between the ages of 8 and 16.

   1 2 3 4 5

3. Your child seemed to enjoy participating in the study.

   1 2 3 4 5

4. You believe children with Autism Spectrum Disorder should participate in exercise programs with their typically developing peers.

   1 2 3 4 5

5. You are happy your child was able to participate in this study.

   1 2 3 4 5

6. You would be willing to take your child to an indoor rock climbing gym again.

   1 2 3 4 5

7. You would like to see similar methods implemented in schools and agencies that provide services to children with Autism.

   1 2 3 4 5

APPENDIX J: PARTICIPANT SOCIAL VALIDITY QUESTIONNAIRE

Social Validity Questionnaire - Children

Child initials: _____

1. Do you think it is important to exercise every day?

   Yes No I don't know

2. Do you think exercising makes you healthier?

   Yes No I don't know

3. Did you enjoy being involved in this program?

   Yes No I don't know

4. Did you like rock climbing?

   Yes No I don't know

5. Do you like rock climbing with your partner?

   Yes No I don't know

6. Would you like to hang out or play sports with your partner?

   Yes No I don't know