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Predicting Reinforcers to Increase Physical Activity in Young Children with Obesity using the Six-Minute Walk Test

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PREDICTING REINFORCERS TO INCREASE PHYSICAL ACTIVITY IN YOUNG CHILDREN WITH OBESITY USING THE SIX-MINUTE WALK TEST

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Predicting Reinforcers to Increase Physical Activity in Young Children with Obesity using the Six-Minute Walk Test

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Childhood obesity continues to be a significant public health problem in the United States in which approximately 8% to 12% of American children are obese (Cunningham, Kramer, & Narayan, 2014; Mirza et al., 2018; Ogden et al., 2014). Further, 42% of American children are engaging in less than the recommended 60 minutes of daily physical activity (Troiano et al., 2008). Several treatments have been evaluated that have included goal-setting, self-monitoring, performance feedback, and access to arbitrary tangible rewards (e.g., Hyusti, Normand, & Larson, 2011; Van Camp & Hayes, 2012), but these treatments have often failed Luttikhuis et al., 2009; Nooijan et al., 2017). Successfully identifying reinforcers for physical activity may lead to an increase in treatment successes in young children with obesity. Previous studies that evaluated procedures to predict reinforcement of physical activity have notably neglected the participation of children with obesity. In addition, previous studies have not included tangible stimuli as possible reinforcers for increasing physical activity.

The current study evaluated modifications to the Six-Minute Walk Test (6MWT, American Thoracic Society, 2002) to predict individualized reinforcers of physical activity in young children with obesity. Reinforcers identified through these procedures were then compared to arbitrarily identified rewards. Three children with obesity between five and nine years old participated in the study. Results demonstrated that using the modified 6MWT as a reinforcer analysis predicted individualized reinforcers that increased physical activity beyond baseline levels, and identified reinforcers that were more effective than arbitrarily-selected rewards. Future research implications and limitations are discussed.

Keywords: *obesity, physical activity, reinforcer analysis*

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LIST OF ABBREVIATIONS

6MWT	Six-Minute Walk Test
ABA	applied behavior analysis
ATS	American Thoracic Society
ASR	arbitrarily-selected reward
BMI	body mass index
bpm	beats per minute
CDC	Center for Disease Control
COVID-19	coronavirus disease
cm	centimeters
FT	fixed-time
HR	heart rate
HR_{max}	maximum heart rate
IOA	interobserver agreement
kg	kilograms
m	meters
MMI	Munroe-Meyer Institute
MSWO	multiple-stimulus without replacement stimulus preference assessment
MVPA	moderate-to-vigorous physical activity
MVPA HR	moderate-to-vigorous physical activity heart rate range
OSRPA-C	Observation System for Recording Physical Activity in Children
s	seconds
SpO_2	oxygen saturation
WHO	World Health Organization

CHAPTER 1

INTRODUCTION

Applied behavior analysis (ABA) has established itself as a fundamental practice in such areas as autism, developmental disabilities, and language acquisition (Association of Professional Behavior Analysts, 2017; National Autism Center, 2015). However, there are other socially-significant problems that impact society for which applied behavior analysis may be used to identify potential solutions (Critchfield & Reed, 2017). One such socially-significant problem is childhood obesity which continues to be a significant medical and public health concern (Mirza et al., 2018). Recent estimates suggest that between 8% and 12% of American children are obese (Cunningham, Kramer, & Narayan, 2014; Ogden et al., 2014). Studies further indicate that the prevalence of obesity in American children increases as children age. Ogden and colleagues (2016) estimated that 9.4% of American children between the ages of two- and five-years are obese and the prevalence of obesity nearly doubles for children who are six to eleven years old.

Childhood Obesity

Fundamentally, childhood obesity is the result of a caloric imbalance in which caloric intake (e.g., eating) is greater than output (e.g., physical activity; (Epstein, Myers, Raynor, & Saelens, 1998; Epstein, Roemmich, & Raynor, 2001; Hebebrand & Hinney, 2008). Diagnostically, childhood obesity is defined as having a Body Mass Index (BMI) score at or above the 95th percentile relative to norms established by the Center for Disease Control and Prevention (CDC, 2018). BMI is a cornerstone calculation that estimates overall health. The calculation takes into account an individual's height, weight, age, and sex (CDC, 2018). BMI is often used as a way to identify individuals who are at high risk of health problems related to obesity. Data suggest that approximately 4% and 6% of American children have a BMI greater than 99th percentile (Ogden et al., 2016; Skelton, Cook, Auinger, Klein, & Barlow, 2009).

Childhood obesity may be the result of genetic disorders such as Beckwith-Wiedemann Syndrome, Fragile-X Syndrome, or Prader-Willis Syndrome (Mirza et al., 2018). Other causes of obesity may be due to environmental variables such as access to high-caloric/high-fat foods, limited access to exercise space (e.g., playground, park), and increased screen time (Schroeder & Smith-Boydston, 2017). Childhood obesity has been linked to multiple health problems including greater risk for cardiovascular disease, diabetes (Daniels, 2009), and sleep disorders, as well as bone and joint problems (Hebebrand & Hinney, 2008; Mirza et al., 2018; World Health Organization [WHO], 2014). Children with obesity are also more likely to become obese adults with greater risk for heart disease, type II diabetes, stroke, cancer, and osteoarthritis (Mirza et al., 2018).

In addition to health problems, childhood obesity has also been linked to detrimental effects for children's peer interactions and mental health. Young children with obesity are more likely to experience pervasive weight stigmatization (Harrist et al., 2016; Puhl & Latner, 2007). Children with obesity are also more likely to encounter bullying based on their weight (van Geel, Vedder, & Grilo, 2014). Some studies indicate that stigmatization and bullying actually intensify as a child's weight increases (Puhl, Luedicke, & Grilo, 2014). Stigmatization and bullying are correlated with higher rates of depression, social isolation, lower self-esteem, and a relatively poorer quality of life compared to same-age, healthy-weight peers (Small & Aplasca, 2016). Therefore, it is important to intervene early to effectively treat children with obesity. In addition, young children by definition have relatively short learning histories engaging in sedentary behaviors and unhealthy eating habits. Early intervention provides the opportunity to address these behaviors that contribute to childhood obesity which may also be more readily modified at young ages (American Psychological Association, 2020).

Most strategies to decrease caloric intake include the reduction or elimination of high-caloric foods (Luttikhuis et al., 2009; Spear et al., 2007). Increased physical activity has also been identified as a necessary component in the treatment and prevention of childhood obesity (Normand, Dallery, & Ong, 2015; Luttikhuis et al., 2009; Rajjo et al., 2017; Spear et al., 2007). Increases in physical activity increase energy expenditure which, when combined with a reduction of caloric intake, can result in the reduction of body weight (Luttikhuis et al., 2009; Rajjo et al., 2017). However, contrary to caloric reduction strategies, there is not a consensus among health care professionals regarding what approaches constitute effective interventions to increase physical activity in children with obesity (Noojien et al., 2017). The focus of the current paper examined strategies to increase physical activity in young children with obesity.

Physical Activity and Childhood Obesity

The Center for Disease Control (CDC, 2018) and the World Health Organization (WHO, 2014) recommend that children engage in at least 60 minutes of physical activity per day to prevent childhood obesity and improve overall health. Increases in physical activity have been found to improve overall bone health (Janz et al., 2010) and cardiovascular fitness, increase energy, reduce risk of developing heart disease, cancer, type II diabetes, and prevent obesity into adulthood (CDC, 2018; Daniels et al., 2009; Jannsen & LeBlanc, 2010).

Despite the known health benefits of physical activity, most children do not engage in the recommended level. Estimates suggest that only 42% of American children under age 11 engage in physical activity for the recommended 60 minutes per day (Troiano et al., 2008). Tucker (2008) also found that only 54% of preschoolers engage in recommended daily levels of physical activity. It has been established that children with obesity under the age of 11 engage in significantly less physical activity compared to their nonobese peers (Cooper et al., 2015; Hills, Andersen, & Byrne, 2011; Hughes et al., 2006; Page et al., 2005; Spear et al., 2007).

Treatment and Treatment Failure to Increase Physical Activity

The treatment of childhood obesity by increasing physical activity has been evaluated by researchers in the field of ABA. For example, DeLuca and Holborn (1985; 1990; 1992) demonstrated that contingent token delivery increased bicycle pedaling in obese and nonobese children. Similarly, DeLuca and Holborn (1985) used tokens delivered on a 1-min fixed-interval schedule to increase the duration of bicycle pedaling in both obese and nonobese children. DeLuca and Holborn (1990) extended on these findings by demonstrating that bicycle pedaling increased when token reinforcement was delivered on a fixed-ratio schedule of reinforcement compared to a fixed-interval schedule. Finally, DeLuca and Holborn (1992) demonstrated increases of duration and pedal revolutions when bicycle pedaling was reinforced on a variable-ratio schedule within a changing-criterion design. However, these treatment effects were not replicated in naturalistic settings (e.g., playground, community) beyond the laboratory.

More recently, Patel and colleagues (2019) also evaluated the effects of token economies on the rate of moderate to vigorous physical activity (MVPA) of four healthy, nonobese preschool children. Using a treatment-reversal design within a multiple-baseline design, in which noncontingent and contingent access to token reinforcers were compared to baseline conditions, contingent access to token economies yielded greater rates of MVPA compared to baseline for three of four participants. The results provided additional evidence that token economies may increase the rates of physical activity in young, nonobese children.

Multi-component treatment packages have also been evaluated by researchers in ABA. Hustyi, Normand, and Larson (2011) evaluated a package intervention to increase physical activity of two obese preschool children. The treatment package included goal-setting, performance feedback, and contingent access to a prize box that contained small tangible items (i.e., stickers, stamps, etc.). Using a reversal design, the authors demonstrated modest increases in physical activity for one child but not for the other. The authors hypothesized that neither attention in the form of performance feedback nor access to tangible items functioned as reinforcers to increase physical activity for one of the participants. Hayes and Van Camp (2015) also used a packaged intervention to increase steps taken and the levels of physical activity of six typically-developing, nonobese girls. Results indicated that steps taken and physical activity increased using the packaged intervention, but it was unclear which component of the packaged intervention was most effective in increasing steps taken and physical activity.

Researchers outside of ABA have suggested that effective strategies that increase physical activity in young children with obesity are difficult to identify and predict. For example, a meta-analysis of 33 studies that evaluated treatments aimed to increase physical activity in children with obesity concluded that combinations of physical fitness (e.g., endurance or strength exercise), behavioral (e.g., consequence-based interventions), and environmental treatment components (e.g., change to the context of physical activity) were ineffective in increasing physical activity in children with obesity (Nooijen et al., 2017). Other reviews have also suggested that patterns of physical activity in children with obesity are also difficult to change (Kamath et al., 2008; Metcalf, Henley, & Wilkin, 2012).

Treatments to increase physical activity in obese children may fail because they are typically not individualized, often taking a "one-sized-fits-all" approach (Wilfley et al., 2018). By taking a "one-size-fits-all" approach to increase physical activity, treatments may neglect idiosyncratic differences between and across individual children. Neglecting these idiosyncratic differences, such as reinforcer preference, may contribute to treatment failure for some individuals (Carr & Epstein, 2020; Epstein, Smith, Vara, & Rodefer, 1991; Nooijen et al., 2017; Spear et al., 2007).

Treatments may also fail because children with obesity may prefer sedentary as compared to physical activity. Several researchers have suggested that the more obese a person is, the less likely they are to identify physical activity as a preferred activity (Epstein et al., 1991; Wing & Phelan, 2005). Further, increasing physical activity may incidentally increase the reinforcing value of sedentary activity. For example, increasing amounts of exercise may, in turn, increase the reinforcing value of food as additional calories are required by individuals as they exercise (Carr & Epstein, 2020; Flack et al., 2019; Wilfley et al., 2018). Therefore, it is important to identify and predict reinforcers of physical activity that compete against the reinforcing value of sedentary activity.

As noted earlier, treatments to increase physical activity typically include goal-setting, performance feedback, and access to tangible stimuli. However, the tangible stimuli used to reinforce physical activity are often arbitrarily selected (Hustyi et al., 2011; Van Camp & Hayes, 2012). The use of arbitrarily-selected stimuli as contingent rewards for physical activity are contradictory to current research on stimulus preference. Research suggests that there are individual differences with stimulus preference (Fisher et al., 1992; Nuernberger, Smith, Czarpar, & Klatt, 2012), and that the use of preferred stimuli as rewards generally positively affects treatment outcomes (Kodak, Northup, & Kelley, 2007; Piazza et al., 1996; Piazza, Roane, & Karsten, 2011). Evaluating stimulus preference to identify reinforcers may decrease treatment failures. Additionally, given that the effectiveness of rewards may fluctuate over time, stimulus preference assessments can be re-administered to identify currently preferred stimuli (Kelley, Shillingsberg, & Bowen, 2016; Langthorne & McGill, 2009).

Identification of preferred stimuli may lead to more effective treatment outcomes in increasing physical activity. Identifying effective, individualized treatments that compete against contingencies that reinforce sedentary behavior, however, is difficult (Wilfley et al., 2018). Therefore, an evaluation of procedures that systematically identify and predict reinforcers of physical activity may lead to more effective, individualized treatments increasing physical activity in young children with obesity.

Experimental Analyses of Reinforcers for Physical Activity

To date, three studies have evaluated potential reinforcers of physical activity designed to increase physical activity in young children (Larson et al., 2013, 2014; Zerger, Normand, Boga, & Patel, 2016). Procedures have included systematic manipulations of antecedent and consequence events that occasion and reinforce the occurrence of physical activity. Procedures used in these studies were adapted from those used to evaluate the function of problem behavior such as self-injury, physical aggression, and pica (Larson et al., 2014). Four contingencies have been evaluated: contingent attention (i.e., praise statements), interactive play (i.e., playing with the child), alone (i.e., child playing alone with no additional consequences), and escape (i.e., removal of an aversive event).

All three studies included healthy, nonobese participants between three- and five-years-old. Physical activity was measured using a behavioral observation system that included 1-s partial interval recording of sedentary movement, slow/easy movements, and moderate-to-vigorous physical activity (McIver et al., 2009; Larson, Normand, & Hustyi, 2011). All three of the studies were conducted on a community playground that included fixed-equipment (e.g., slide, swings) and used video analysis to aid in data collection.

Larson et al. (2013, 2014) evaluated procedures to identify the effect of contingent attention, interactive play, alone, or escape conditions on the occurrence of moderate-to-vigorous physical activity (MVPA). During contingent attention conditions, participants received the experimenter's attention in the form of verbal praise (i.e., "*great job running!*"). During the interactive play conditions, the participant received brief bouts of attention on an FT 30-s schedule contingent on MVPA. In addition, the experimenter played with the participant for as long as they engaged in MVPA. If the child stopped MVPA, the experimenter would stop playing with the child. During the alone condition, the participant was given access to the playground, but the experimenter was out-of-sight of the participant. During the escape condition, the participant was given non-play activities in the form of chores (i.e., cleaning up the playground, organizing equipment). Instructions were delivered by the experimenter to the child on an FT 30-s schedule and ceased for 30 s when MVPA was observed. The control condition involved access to sedentary activities and noncontingent delivery of attention on a fixed-time schedule. No other consequences for MVPA were provided. Results indicated that contingent attention maintained MVPA for four of six participants. For two remaining participants, the occurrence of MVPA was greatest during both the contingent attention and interactive play conditions.

Zerger and colleagues (2016) used the procedures described above to evaluate the effects of interactive play and contingent attention on the occurrence of MVPA of seven healthy, nonobese four- to five-year-olds. Results suggested that, for two of the children, contingent attention maintained MVPA, while interactive play maintained MVPA for another child. For two of the seven children, both contingent attention and interactive play maintained MVPA. However, the experimental procedures failed to predict a functional reinforcer that maintained the MVPA of two children. Zerger and colleagues (2016) extended upon the previous two studies (Larson et al., 2013, 2014) by comparing the effects of response-contingent and time-based reinforcers. Results of the treatment analysis suggested that, for four of the five participants, response-contingent reinforcement was effective. However, for one participant, it appeared that procedures were unable to identify a reinforcer of physical activity. Following failed treatment for this particular participant, a second experimental analysis was completed to reevaluate a more effective reinforcer of physical activity.

The results of the second experimental analysis were undifferentiated, suggesting that either preferred topographies of attention were not available, or they were under the control of another reinforcer class (e.g., tangible). In other words, treatment derived from the experimental analysis failed because not all potential classes of reinforcers to promote physical activity were evaluated. Procedures failed to predict an effective reinforcer designed to increase physical activity for three out of seven participants in the study.

Limitations to Current Methodology.

Previous ABA studies of childhood obesity have attempted to adapt functional analysis procedures typically used with high-rate problematic behavior to identify functional relations for low-rate physical activity. While functional anlaysis has led to effective treatments of several topographies of problem behavior such as self-injurious behavior, property destruction, disruption, and pica (Beavers, Iwata, & Lerman, 2013; Hanley; Iwata & Dozier, 2008), adapting these types of methods used to identify functional relations does not readily apply to identifying reinforcers to increase low-rate behaviors such as physcial activity (Hofstadter-Duke & Daly, 2015; Holden, 2002).

Procedurally, there are four limitations in the previous investigations of physical activity. First, previous studies did not include a fundamental class of positive reinforcement in the form of access to tangible reinforcement. *Contingent* tangible reinforcement has been used to attempt to increase physical activity in some young children with obesity (DeLuca & Holborn, 1985; 1990; 1992) and some young healthy children (Huysti et al., 2011; Patel et al., 2019; Van Camp & Hayes, 2012, 2015). Experimental analyses, however, yielded undifferentiated results for 23% of participants (*Table 2*, Larson et al., 2013, 2014; Zerger et al., 2016). The procedures used within these studies may have neglected a potential reinforcer class such as tangible reinforcement. However, an evaluation of tangible reinforcement on physical activity may be difficult because providing access to tangible reinforcement during physical activity may disrupt the child from engaging in physical activity (DeLeon et al., 2014; Patel et al., 2019).

The use of token economies during interventions to increase physical activity have demonstrated effectiveness. The accumulations of reinforcement through tokens provided participants with immediate, conditioned reinforcement of physical activity. The use of token economies provides delayed access to the terminal reinforcer (e.g., toy) at the end of a period of time, but continues to provide immediate reinforcement through contingent access to a token exchange later. Thus, a token economy provides immediate reinforcement without disruption to the intervention (DeLeon et al., 2014; Hackenberg, 2009). The current study used contingent token reinforcement to evaluate effects of positive reinforcement in the form of *preferred* tangible stimuli, as compared to other stimulus classes previously evaluated, such as contingent attention and interactive play.

Second, previous studies have neglected to include young children with obesity despite physical activity being identified as a necessary component for the treatment of childhood obesity (Normand, Daller, & Ong, 2015; Luttikhuis et al., 2009; Rajjo et al., 2017; Spear et al., 2007). Given that young children with obesity generally engage in much less physical activity than healthy, nonobese peers (Cooper et al., 2015; Hills et al., 2011; Page et al., 2005; Spear et al., 2007; Tucker, 2008), predicting functional reinforcers for physical activity as an alternative to sedentary activity may lead to an increase in physical activity of children with obesity (Carr & Epstein, 2020; Epstein et al., 1991; Wing & Phelan, 2005).

Third, the previous investigations have not included analyses comparing the effects on physical activity following the contingent delivery of putative reinforcers identified by a reinforcer analysis versus treatments using arbitrarily-selected rewards (ASR; e.g., Hustyi et al., 2011). Treatments to increase physical activity have typically not included a direct analysis of preferred reinforcers to increase physical activity in children with obesity (Carr & Epstein, 2020; Nooijen et al., 2017; Wilfley et al., 2018). A comparison of such treatments (e.g., putative reinforcers versus arbitrary rewards) underscores the importance of stimulus preference assessment in identifying reinforcers for physical activity for treatment of obesity in young children.

Larson et al. (2013) failed to include treatment trials in their initial research design, and only included a comparison to the baseline in their second study (2014). Zerger and colleagues (2016) compared contingent reinforcement to time-based reinforcement but did not evaluate the effect of putative reinforcers as compared to ASRs upon physical activity. Further, evidence provided by the authors suggested negligible differences in contingent and time-based reinforcement of physical activity in two of four participants in which a reinforcer was utilized. Procedures that can predict empirically-derived, individualized, and effective reinforcers to increase physical activity in obese children could increase the efficacy of treatment and prevent intervention failures.

Finally, previous studies using experimental analysis did not include proxy measures of overall health. The procedures used by Larson et al. (2013, 2014) and Zerger et al. (2016) did not include dependent variables that measured potentially important physiological indicators of overall health, such as heart rate (HR) and oxygen saturation levels ($SpO_{2;}$ Ekman, Klitenberg, Bjoerck, Norstroem, & Ridderstale, 2013). The inclusion of procedures that measure overall fitness measures can increase the clinical utility of a reinforcer analysis of physical activity beyond just increasing physical activity. Measurement of these physiological variables associated with good health can aid practitioners in identification of efficacious treatments to improve the overall health of young children with obesity. It is important to include proxy health measures in attempts to improve physical activity for safety reasons given that children with obesity are often at risk of other health deficits. One such health fitness measure that includes proxy measures of overall health is the Six-Minute Walk Test (6MWT; Ekman et al., 2013).

Six-Minute Walk Test (6MWT)

A procedure that can be used to systematically evaluate and predict reinforcers of physical activity is the 6MWT. The 6MWT is an exercise assessment used to evaluate the effectiveness of interventions to improve overall health. The 6MWT procedure estimates an individual's overall fitness by measuring distance walked, HR, and SpO_2 (American Thoracic Society [ATS], 2002). The test can be conducted indoors or outdoors where there is access to at least a 30-m course or straight, flat path (ATS, 2002). Some experimenters have, however, successfully adapted procedures using a variety of distances (Cacau et al., 2016; Klepper & Muir, 2011). Geiger and colleagues (2007) used a 20-m course; while Lammers et al. (2008) used courses ranging from 30 to 50 meters.

Previous experimental analyses included outdoor access to playground equipment (Larson et al., 2013, 2014; Zerger et al., 2016). Although a playground with fixed-equipment is likely a setting in which physical activity is likely to occur, lack of access to playground equipment may hinder other health professionals from using such procedures. The inclusion of playground equipment in assessment procedures may be restrictive to many applied settings.

The 6MWT requires that an individual walk at his/her own pace for six minutes. The individual is free to walk for as long, or as little as they wish without any programmed consequences. No feedback is provided to the individual during the 6MWT except for an announcement of how much time is remaining which is done every minute until the test is completed (ATS, 2002; Geiger et al., 2007).

The results of the 6MWT provide clinicians with information on physical performance and changes in overall fitness as measured by distance walked, HR, and estimates of oxygen saturation. Clinicians may also learn about the individual's pattern of movement, posture, joint movement, and endurance (ATS, 2002; Morinder et al., 2009). The 6MWT has been used to measure an individual's response to medical interventions to treat severe heart or lung disease (ATS, 2002). The 6MWT has also been used to measure the effectiveness of interventions to increase physical activity in young children with obesity (Morinder et al., 2009). Effectiveness of an intervention on overall fitness is determined by pre- and post-intervention performances. The 6MWT is used as a dependent measure to evaluate the effectiveness of interventions to increase physical fitness in young children with obesity. The 6MWT does not, however, predict treatment efficacy (Morinder et al., 2009; Ekman et al., 2013), nor does it predict an effective class of reinforcers to increase physical activity in individual children. Specific modifications to the 6MWT can produce information that can aid researchers and practitioners in predicting and identifying reinforcers of physical activity of children with obesity.

Purpose of the Study

Limitations of previous investigations (Larson et al., 2013, 2014; Zerger et al., 2016) warrant additional evaluation of procedures designed to identify and predict individualized and systematically-derived reinforcers of physical activity in young children with obesity. Treatments to decrease childhood obesity often fail because they lack individualization. Individualization and early intervention to increase physical activity can aid in decreasing the prevalance of childhood obesity (APA, 2020; Normand et al., 2015; Luttikhuis et al., 2009; Rajjo et al., 2017; Spear et al., 2007).Therefore, additional investigations evaluating procedures that predict reinforcers that increase physical activity in young children with obesity should be conducted.

The current study aimed to address procedural limitations in previous research noted above. First, the current study included a condition in which contingent, but delayed, access to preferred items through a token economy was evaluated as a possible reinforcer of physical activity. Second, the current study utilized data from an adapted 6MWT procedures to assess effectiveness of individualized treatment to increase physical activity in young children with obesity. Third, the current study used information from the modified 6MWT to evaluate the effects of putative individualized reinforcers as compare to ASRs commonly used in treatments to increase physical activity in young children with obesity (see DeLuca & Holborn, 1985, 1990, 1992; Hustyi et al., 2011). Lastly, the current study targeted young children with obesity, a feature not included in previous studies evaluating reinforcers of physical activity (Larson et al., 2013, 2014; Zerger et al., 2016).

CHAPTER 2

METHODS

Participants

Children between three- and eight-years-old were recruited for participation in the current study. Participants were recruited by the experimenter through flyers posted in area pediatrician offices, and at university clinics. Phone calls to local pediatricians in the Omaha, Nebraska metropolitan area describing the study were also conducted by the experimenter.

Participants needed to meet the CDC's diagnostic criteria for childhood obesity, defined as having a body mass index at or above the 95th percentile derived from gender and age norms (CDC, 2016). Body mass index is calculated by dividing the child's weight (kg) by height (cm) then dividing the quotient by the child's height once again and multiplying this number by 10,000.

In order to be included in the current study, participants must have walked an average of one standard deviation below current 6MWT distance norms for their age group (Geiger et al., 2007). For male participants between three- and five-years-old to be included in the current study, average distance walked needed to be below 441 m on the 6MWT during baseline trials. Male participants, either seven- or eight-years-of age, must have walked an average less than 522 m during initial screening (Geiger et al., 2007).

For eligibility, female participants between the ages of three- and five-years had to have walked less than 412 m on the 6MWT during screening trials (Geiger et al., 2007). Female participants between six-, and eight-years-old must have walked an average of less than 504 m during initial screening. All children participating in the current study passed a physical screening conducted by a medical professional (i.e., pediatrician) stating that participation in the current study was safe.

Exclusion criteria included children with a physical disability that might have inhibited or limited mobility required by the 6MWT; children who required the aid of mobility devices (i.e., wheelchair, walker); and children who engaged in severe problem behavior (e.g., self-injurious behavior, physical aggression, and pica). Two male and two female children were consented for the study. Three children completed the study while the remaining child's parents withdrew him from the study during the COVID-19 pandemic period. Participants received compensation of $50 for completion of the study. Compensation was made available to families to aid in the recruitment of potential participants.

Anders was a five-year-old male whose body mass index was at the 98th percentile with a weight of 29.4 kg and height of 122 cm at the time of study. Ashley was a seven-year-old female whose body mass index was above the 99th percentile with a weight of 41.4 kg and a height of 141 cm at the time of the study. Finally, Anne was a seven-year-old female with a body mass index at the 98th percentile weight of 37 kg and a height of 132 cm. All three children who participated in the current study walked on average less than one standard deviation below normative means during initial screening.

Setting

All experimental sessions were conducted on the campus of the University of Nebraska-Medical Center's Munroe-Meyer Institute for Genetics and Rehabilitation (MMI) in Omaha, Nebraska. Parent interviews, stimulus preference assessments during the reinforcer analysis, and all experimental trials were conducted at the J. P. Lord School gymnasium. In order to fit all experimental trials into a recording camera frame, a 15 m course inside the gymnasium was used as 100 m, 50 m, and 30 m courses were difficult to obtain and fit within the camera frame necessary for data collection. During the treatment analysis, all experimental conditions were conducted on the outdoor playground at MMI which included slides, ladders, swings, rockers, monkey-bars, and open space. The outdoor playground at MMI was approximately 18 m by 15 m, or $270m^2$.

Dependent Variables and Measures

Distance Walked

Distance walked in meters was the primary dependent variable used during Phase I (baseline) and Phase II (reinforcer analysis). Distance walked was has historically been the primary dependent variable used in studies for decision-making using the 6MWT (ATS, 2002; Geiger et al., 2007). The experimenter and another trained experimenter collected data on the number of 15-m laps taken during each trial during Phases I and II. At the end of each six-minute trial, the experimenter instructed each participant to stop and remain stationary. The experimenter and a trained experimenter then used a measuring wheel to calculate the distance between the closest distance marker behind the participant and the participant's toe. Total distance was calculated by the number of 15-m laps walked plus distance between the last marker and the participant’s toe. Meters walked was recorded at the end of each 6MWT trial.

Direct Observation of Physical Activity

The experimenter and trained observers also recorded subjects’ activity level data using a modified *Observation System for Recording Physical Activity in Children* (OSRPA-C; McIver et al., 2009) to measure levels of physical activity during Phase III (treatment analysis). The OSRPA-C defines physical activity along a continuum of behavior that includes sedentary activity, slow movements, easy movements, moderate physical activity, and vigorous physical activity (MVPA; Brown et al., 2006; Larson, Normand, & Hustyi, 2011; McIver et al., 2009). Larson et al. (2011) evaluated the concurrent validity of the OSRPA-C total step count using pedometer and HR. Results indicated that HR increased with more intense levels of physical activity observed using OSRPA-C. The results also indicated that pedometer readings are less sensitive than HR at matching observational data.

Table 1 illustrates the modified OSPRA-C physical activity levels. Sedentary activity was operationalized as motionless or stationary movements with no major limb or joint movements with no translocation (e.g., sitting, standing; McIver et al., 2009). Slow/easy movements were operationalized as translocation at a slow and easy pace (e.g., walking, slow cycling, climbing ladder; McIver et al., 2009). Finally, MVPA was operationalized as translocation at a moderate to fast pace such as running, skipping, or jumping (Larson et al., 2011, 2013; McIver et al., 2009; Zerger et al., 2016).

All data collection of activity levels during the Phase III (treatment analysis) was conducted using the OSRPA-C. The current study used a modified 3-s momentary-time sampling recording system to collect data on physical activity during the treatment analysis. Previous studies used a 1-s partial interval in their analysis of MVPA of non-obese children using frame-by-frame video analysis (Larson et al., 2013, 2014; Zerger et al., 2016). Choice of a 3-s momentary-time sampling recording system was due to greater feasibility compared to 1-s partial interval recording.

Total Steps

Total step counts were collected for each trial during the reinforcer analysis and treatment analysis phases of the study using pedometers. Pedometers were used in previous studies (Hustyi et al., 2011; Larson et al., 2011) to provide a direct measure of physical activity. Pedometers are more often preferred over direct observation of step count (Van Camp & Hayes, 2012) and have demonstrated good concurrent validity, or accuracy, compared to direct observation of physical activity (Husted & Llewellyn, 2017; Hustyi et al., 2011; Larson et al., 2011). Step count was used as a direct measure of physical activity during baseline and ASR trials in Phase III (treatment analysis) of the study.

Heart Rate and Oxygen Saturation

HR and SpO_2 were collected before each trial following a two-minute resting period and immediately following the end of all trials of the study. At the beginning of each session, a resting heart rate was determined following an initial ten-minute rest period before the start of all trials for the day. Resting heart rate was used to monitor safety and to also estimate when the participant was rested. HR ranges obtained from the Geiger et al. (2007) study were used to evaluate the safety of the participants. No additional instructions or concerns from any of the participants' pediatricians were provided to the experimenter.

Geiger and colleagues (2007) measured resting HR and post activity HR for male and female participants between the ages of three- to nine-years-old prior to the 6MWT. Results indicated that, for male children between three- and five-years-of age, pre-test resting HR was between 87 and 107 beats per minute (bpm) with post-test HRs between 126 and 168 bpm. For male children between six- and eight-years-old, pre-test HR was between 75 and 101 bpm and a post-test HR between 114 and 152 bpm. For female participants aged three- to five, pre-test HR ranged between 87 and 108 bpm, and post-test HR ranged between 125 and 175 bpm. For female participants between six- and eight-years-old, pre-test HR ranged between 82 and 110 bpm, and a post-test HR between 129 bpm and 160 bpm.

In the current study, HR and SpO_2 were measured by a finger pulse oximeter (*Fingertip Pulse Oximeter* model # MD300C29, ChoiceMMed, Bristol, PA). A pulse oximeter is a device that measures relative SpO_2 levels in an individual by using beams of light that are emitted from the device into the individual's fingertip (Fahy, Lareau, & Sockrider, 2011). Pulse oximeters are relatively accurate when compared to direct physiological measures such as arterial blood gas tests which require a blood draw from the radial or femoral artery (Ross, Christopher, Newth, & Khemani, 2014). HR and SpO_2 were recorded by the experimenter and a trained experimenter. SpO_2 levels were used to evaluate the health and physical safety of the participants during the current study. SpO_2 levels are reported as percentages of red blood cells that carry oxygen. Typically, SpO_2 levels at or above 89% are considered to be healthy and those levels below 80% are considered to be dangerous (Fahy et al., 2011).

Procedures

The current study consisted of three phases (*Figure 1*). The first phase included obtaining consent for the study, interviewing caregivers about the participant's physical activity habits and obtaining baseline fitness using the 6MWT. If the participant met inclusionary criteria during

Phase I (baseline), the participant entered Phase II (reinforcer analysis). Phase II included the reinforcer analysis using preference assessment to predict reinforcers of physical activity. Phase II used data from the modified 6MWT to conduct an experimental analysis of influences upon physical activity (i.e., walking, running, skipping). Results of the reinforcer analysis of physical activity were then used to inform the putative treatment condition during Phase III (treatment analysis which compared the effects of putative reinforcement versus ASR on increases in MVPA.

Training Other Experimenters

Other experimenters were recruited by the experimenter to assist with data collection for Phases I – III. The role of the other experimenters was to collect interobserver agreement (IOA) and procedural integrity data during all trials. Two experimenters were trained to implement all trials for Anders. The experimenter reviewed all Anders's trials and obtained IOA for Anders's reinforcer analysis and treatment analysis trials. The primary experimenter trained the other experimenters by reviewing operational definitions of dependent variables and reviewing all procedures for all three phases of the study. The experimenter used a videotape of a non-participant child participating in experimental trials described in Phases I – III to train the additional experimenters prior to the start of the current study. The experimenter also provide written instructions, verbal feedback, visual performance feedback, and *in-vivo* feedback during pre-study training. The experimenters needed to obtain at least 90% IOA with the experimenter for three consecutive trials observed across all three phases before assisting with the study.

Interobserver Agreement

Interobserver agreement (IOA) of distance walked during the reinforcer analysis was obtained by two independently trained experimenters measuring meters walked and obtaining the distance walked within 0.1 m. IOA on meters walked during the reinforcer analysis was collected for all trials for all participants. The mean IOA for meters walked across all participants was 100%.

IOA on the percentage of intervals with MVPA within a trial was calculated by dividing the number of agreements by the number of trials observed, then multiplying by 100. IOA was also calculated for each topography of physical activity (e.g., MVPA, slow/easy movements, and sedentary behavior) for 29% of all treatment analysis trials across all participants. Mean interval-by-interval agreement across all participants was 92.4%. Mean interval-by-interval for Anders was 96% (range, 93% to 98%), for Ashley 92% (range, 88% to 98%), and for Anne 90% (range, 83% to 94%).

During the treatment analysis, mean agreement for MVPA was 90% (range, 50% to 100%) across all participants. Mean agreement of MVPA for Anders was 96% (range, 89% to 100%), for Ashley 93% (range, 80% to 100%), and for Anne 80% (range, 50% to 100%). It should be noted that the trial in which agreement of MVPA was 50% only two intervals of MVPA were observed and that interval-by-interval agreement for all topographies of physical activity was 94%. Mean agreement for slow/easy movements was 92% (range, 84% to 100%) across all participants. Mean agreement of slow/easy movements for Anders was 93% (range, 89% to 100%), for Ashley 88% (range, 84% to 90%), and for Anne 90% (range, 80% to 97%). Mean agreement of sedentary activity was 93% (range, 79% to 100%) across all participants. Mean agreement of sedentary activity for Anders was 97% (range, 93% to 100%), for Ashley 92% (range, 88% to 97%), and for Anne 91% (range, 79% to 98%).

Procedural Integrity

Procedural integrity was collected by a second experimenter for a portion of all stimulus preference assessment across participants and phases. Procedural integrity was scored positively if the second experimenter observed the first experimenter implement a stimulus preference assessment component correctly, and if both experimenters scored the participant’s selection the same. Procedural failure was scored if the primary experimenter implemented a component of the stimulus preference assessment incorrectly, or omitted a component. Procedural failure was also scored if either experimenter scored the participant’s selection incorrectly. The second experimenter hand-scored and observed all stimulus preference assessments. Procedural integrity was 100% for all stimulus preference assessments.

Procedural integrity was collected for at least 33% of all experimental trials for each phase of the current study. A second trained experimenter independently collected procedural integrity data during experimental trials or by reviewing video-recorded sessions using the data collection sheets for the reinforcer analysis (*Figures 2-5*) and treatment analysis (*Figure 6-8*). Procedural integrity was rated positively when both observers scored a specific component as implemented as written and with accuracy. Procedural failure was scored when an observer scored specific component as implemented with error, not implemented with accuracy, or if a component was unnecessarily implemented. Procedural integrity was calculated by dividing the number of components implemented accurately by the number of components observed. The quotient was then be multiplied by 100 to obtain a percentage of procedural integrity. Procedural integrity was reported to be 100% for the reinforcer analysis trials and the treatment analysis trials with 100% agreement across two observers.

Phase I: Baseline Six-Minute Walk Test

A semi-structured interview was conducted with parents/caregivers of the participants to identify potential stimuli for use during systematic stimulus preference assessment. The semi-structured interview included categorical descriptions of stimulus classes and conditions under which identified stimuli are used. Results of the semi-structured interview were used to inform specific topographies of stimuli for inclusion in the stimulus preference assessment (Fisher, Piazza, Bowman, & Amari, 1996). For Anders, his parent identified toy figures, noise-makers, and adult attention as likely reinforcers. For Ashley, her parent identified that adult attention, small toys, and games were likely reinforcers. And for Anne, the parent identified small toys, noise-makers, and adult attention as likely reinforcers.

Baseline trials were also conducted during Phase I. Baseline trials were conducted consecutively until stability of the baseline was established through visual inspection. A minimum of four baseline trials were conducted in each session. Baseline continued until stability was established. Baseline performance was also used to determine eligibility for participation in the study.

Phase II: Reinforcer Analysis of Physical Activity Using the Six-Minute Walk Test

Following a stable baseline, an alternating treatments design was used to evaluate the effectiveness of various consequences designed to increase greater amounts of walking (Barlow & Hayes, 1979). The order of experimental trials were counter-balanced. Distance walked across all experimental conditions was used as the dependent variable identifying the individualized putative reinforcers to be used during Phase III (treatment) of the study. Visual inspection included analyzing potential level changes, stability, and trends identified in the data (Kratochwill et al., 2013).

Before each daily session, which may have included multiple trials, three multiple stimulus without replacement (MSWO) preference assessments were conducted to identify preferred topographies of attention (Nuernberger, Smith, Czapar, & Klatt, 2012), and tangible stimuli (DeLeon & Iwata, 1996). Pictorial representation of social interactions (Nuerenberger et al., 2012) identified by the caregiver interview was used in an MSWO arrangement. Before each stimulus preference assessment, the experimenter restricted access to the stimuli to be used within the assessment procedure before administration (Lill, Shriver, & Allen, in press). Restricting access to stimuli included in the stimulus preference assessment has been demonstrated to increase the selection or engagement of lesser-preferred items during stimulus preference assessment (Chappell, Graff, Libby, & Ahearn, 2009; Gottschalk, Libby, & Graff, 2000; Klatt, Sherman, & Sheldon, 2000).

During the MSWO of attention, six pictures were randomly arranged in two rows of three approximately 3 cm apart. Pictures were presented simultaneously to the child. During the MSWO of tangible stimuli, six tangible items were randomly arranged in two rows of three approximately 3 cm apart. Immediately following stimuli presentation the experimenter instructed the child to "*pick one*" and started the timer. The participant had 10-s to make a choice. Following selection, the child was praised for making a selection and received 15-s access to the chosen stimulus. Each trial ended following post-selection access. Each MSWO continued until all six trials to make a selection were completed or if the child did not make a selection within 10-s of the stimulus presentation within a trial, the MSWO ended. All remaining trials would then be scored as "no selection". Subsequent MSWO trials were then presented until three MSWOs were completed.. The experimenters hand-scored data on the order of stimuli chosen using the data sheet in *Figure 9*. High-preferred stimuli were identified as the two stimuli that were selected the greatest amount of times relative to the number of times presented, while low-preferred stimuli were identified as the two stimuli that were selected the least amount of times relative to presentations (DeLeon & Iwata, 1996; Nuernberger et al., 2012)

General Procedures

Before the start of each experimental trial, the experimenter guided participants to the start line and reset the pedometer to zero. Following the first experimental trial and before each subsequent trial, the participant was given a two-minute period of rest with moderately-preferred items or until HR as within 25% of resting HR. Following each rest period, the experimenter walked the participant back to the start line and reset the pedometer before stating the rules of each trial. Each trial was videotaped and observed by two trained experimenters. Data was hand-scored using the data sheet in *Figure 10*.

Attention

The attention condition evaluated the potential effects of contingent adult attention on the participant's physical activity by providing the participant with approximately 6 seconds of behavior-specific praise for every continuous 6 seconds of walking observed. To begin the trial, the experimenter stated to the participant, "*Walk as far as and as long as you can for six minutes. You will walk back-and-forth from the green cone* [point], *through the yellow cone to the red cone* [point], *and back. I will be watching you, and if I see you walking, I will cheer you on! If* *you do not walk, I will not be talking. Do your best and walk for as far or as long as you can. Try not to stop until you hear the timer. Ready? Walk!*" During the contingent praise trials, the experimenter stood at the mid-point of the 15-m course to provide contingent attention and collect data on relevant dependent variables.

The specific topography of attention provided was informed by the stimulus preference assessment. The most-preferred topographies of attention were used as a consequence of walking or other forms of physical activity, so long as the participant was moving along the 15-m course. For example, Anders preferred behavior-specific praise. Following 6 consecutive seconds of walking, or other physical activity, the experimenter may have stated "*great job walking on the blue line, you are working so hard!*" The experimenter continued to provide the preferred topography of attention every 6 seconds so long as the participant was observed walking, or engaging in other physical activity. If the participant rested or stopped walking, the experimenter ceased in providing attention in the form of behavior-specific praise. No other contingent consequences of behavior were provided. The participant received a reminder of how much time had elapsed at the three-minute mark by the experimenter (e.g., "*you have 3 minutes to go. Do your best!*").

Interactive Attention

The interactive attention trials evaluated the effect of positive reinforcement in the form of the statements or descriptions of the physical activity observed while walking next to the participant. The interactive attention procedures were adapted from interactive play procedures described by Zerger et al. (2016). Adaptation of these procedures were made to accommodate differences in setting between the current study and the previous study. There were two major adaptations made to the interactive play condition.

First, the experimenter remained standing at the mid-point of the 15-m course to ensure efficient delivery of the contingent consequence rather than remaining within 5 feet of the participant. Given that the space used during the 6MWT was much smaller than most typical playground spaces described by Zerger et al. (2016), the experimenters were able to immediately respond to bouts of walking by providing the programmed consequences described in the procedures below. Second, during reinforcement intervals following the occurrence of walking, the experimenters walked next to the participant. Given that the requirement for the participant to gain adult attention is occasioned by walking, providing play would not necessarily match the contingency tested and may hinder the participant's walking.

To begin the trial, the experimenter then stated to the participant, "*Walk as far as and as long as you can for six minutes. You will walk back-and-forth from this green cone* [point], *through the yellow cone* [point] *to the red cone* [point], *and back. I will be watching you. When you are walking, I will walk beside you and talk with you. If you do not walk, I will stand still and not talk to you. Do your best and walk for as far or as long as you can. Try not to stop until you hear the timer. Ready? Walk.*"

The experimenter provided 6 seconds of interactive attention for every 6 consecutive seconds of walking observed. For example, the experimenter walked next to the participant outside the course and described the physical activity observed. The experimenter may have stated "*we are walking together on the blue line. It is so nice walking with you!"* while the experimenter walked next to the participant. The experimenter continued to walk and talk next to the participant so long as the participant was observed walking. Once the participant rested or stopped walking, the experimenter returned to her/his original position without further interaction until the participant was observed to walk for 6 consecutive seconds. There were no other programmed consequences for behavior. The participant received a single reminder of how much time had elapsed at the three-minute mark by the experimenter (e.g., "*you have 3 minutes to go. Do your best!*").

Tangible

The tangible trials evaluated the effect of positive reinforcement in the form of access to preferred tangible stimuli following bouts of physical activity. Before the initial tangible trial of the session, experimenters conducted teaching trials to expose the participant to the token economy. A token economy was used to provide immediate consequences of walking without interruption to the activity. Token economies are designed to provide conditioned reinforcement to decrease the delay between a response and a consequence that functions as a reinforcer. Accumulation of tokens are then exchanged for access to backup reinforcers (Ayllon & Azrin, 1968; DeLuca & Holborn, 1985; 1990; 1992; DeLeon et al., 2014; Hackenberg, 2009). Results of the stimulus preference assessment for tangible items were used to inform items and values of preferred stimuli that may function as reinforcers.

Teaching trials. Given the participants' age range and the novelty of the contingencies, teaching trials were provided to the participant in order to ensure that the participants understood how to obtain access to preferred items using a token economy. During teaching trials, the experimenter instructed the participant to "*Start walking on the line. Each time you pass these marks on the floor* [point to the 3-m distance marker], *you will earn a point and hear this sound [ring bell]. The more times you hear the bell, the more points you earn, which means you earn better toys.*" After the participant walked for 6 consecutive seconds, the experimenter rang the bell and stated "*you earned one point. You can play with the* [least-preferred item]." The experimenter allowed 15-s access to the least-preferred tangible item indicated by the MSWO. The experimenter then instructed the participant to walk again. After the participant walked for additional six consecutive seconds, the experimenter rang the bell and stated the experimenter then stated "*you earned one more point. You can play with the* [moderately-preferred item]." Following 15-s access to the middle-preferred item, the experimenter instructed the participant to walk. After the participant walked an additional six consecutive seconds, the experimenter stated, "*You earned one more point. You can play with the* [most-preferred item]." The experimenter provided the participant 15-s access to the most-preferred item, then state *"the more times you hear the bell, the more points you earn. The more points you earn, the better the toy you get to play with. Are you ready to earn as many points by walking as much as you can?*"

Experimental Trials. To being each tangible trial, the experimenter stated to the participant, "*Walk as far as and as long as you can for six minutes. You will walk back-and-forth from this green cone* [point], *through the yellow cone* [point] *to red cone* [point], *and back. I will be watching you. When you walk, you will sometimes hear a bell* [ring bell]. *When you hear the bell, you have earned a point. The more times you hear the bell, the more points you earn. The more points you earn, the better the prize you will earn at the end of the six minutes. If you do not walk or do not walk past the lines, you will not hear the bell which means you did not earn a point. Do your best and walk for as far or as long as you can. Try not to stop until you hear the timer. Ready? Walk.*" Each participant earned a point for every six consecutive seconds they were observed walking. During all contingent tangible trials the experimenter stood at the mid-point of the 15-m course to efficiently provide contingent tokens, observe the trial, and collect data on relevant dependent variables.

At the end of each contingent tangible trial, the experimenter calculated the points earned by the participant. The participant was then provided access to the appropriate preferred item from the list of stimuli identified by the MSWO. Once the participant was provided access to a selected stimulus, the participant was given approximately two minutes to engage with the stimulus. High-preferred items were earned if the participant walked more than 175% of the baseline trials. Low-preferred items earned if the participant walked less than 125% of baseline trials. Moderately-preferred items earned if the participant walked between 126% and 174% of baseline trials. No other programmed contingent consequences of behavior were provided. The participant received a reminder to continue walking every minute with the prompt, "you have __ minutes to go. Do your best!" by the experimenter.

Phase III: Treatment Analysis - Comparing Putative Reinforcement and Arbitrarily-Selected Rewards

Following the reinforcer analysis, Phase II, participants for whom a putative reinforcer of physical activity was identified, a treatment analysis was conducted on the playground at MMI. A comparison of putative reinforcement and arbitrarily-selected rewards was conducted using an alternating-treatments design (Barlow & Hayes, 1979). Visual analysis of intervals of MVPA during baseline and experimental conditions were used evaluate the effect of each consequence on the occurrence of MVPA. Visual inspection of data included analyzing potential level changes, stability, and trends identified in the data (Kratochwill et al., 2013).

All trials during the treatment analysis were six minutes in duration. The purpose of Phase III was to evaluate the effects of putative reinforcers identified by the reinforcer analysis and ASR contingencies (e.g., Huysti et al., 2011; Van Camp & Hayes, 2012). A secondary purpose was to demonstrate generalizability of assessment outcomes to naturalistic settings (i.e., playground; see *Figure 10*).

Putative reinforcers were identified by conditions in which distance walked were greatest and by visual inspection of the data across all conditions as described in *Phase II* (Kratochwill et al., 2013). Non-specific treatment trials replicated procedures described by Hustyi et al. (2011) in which participants were given a step goal, provided performance feedback, and contingent access to arbitrarily-selected stimuli (e.g., one item from a prize box) if the step goal was met or exceeded. For data collected during Phase III, treatment analysis, the primary dependent variable was percentage of intervals in which MVPA was observed (McIver et al., 2009; Zerger et al., 2016). Data were hand-scored using the data sheet in *Figure 10.* During the treatment phase, individualized reinforcement identified during the reinforcer analysis was delivered contingent on the occurrence of either slow/easy movements, or moderate-to-vigorous physical activity as defined by the OSRPA-C (McIver et al., 2009).

General Procedures

Each trial was six minutes in duration. At the start of each trial, the experimenter prompted the participant to sit on a bench that was located in the middle of the playground. The experimenter then provided the participant the rules of the trial while resetting the pedometer to zero, and collecting baseline HR and SpO2 levels. Participants were given two minutes of rest between each trial during the daily sessions. Additional time was provided to the participant if HR exceeded 125% of baseline HR, or if the participant requested a break to use the bathroom or obtain a drink. The number of trials during each daily session ranged from four to six trials.

During all experimental trials, the experimenter stood at a centrally-located position on the playground to observe physical activity. From this position, the experimenter collected data on physical activity, provided immediate reinforcement during the interactive play conditions, and signaled the occurrence of reinforcement in the form of bell-ringing during contingent tangible conditions. During the contingent tangible condition, the experimenter also informed the participant of how many points have been earned after each bell ring. Public displays of performance were also posted during the ASR trials and the tangible trials. For ASR trials, the step count goal was posted on a scoreboard located within sight of the participant. Using the same scoreboard, the experimenter also posted the point goal and accumulated points.

Specific procedures

The results from the reinforcer analysis (*Phase II*) were used to inform which putative reinforcer condition to use during the treatment analysis. Only the specific condition that yielded the greatest rate of physical activity, in the form of meters walked, was included in the comparison between putative reinforcement and ASR (Hustyi et al., 2011). For Anders and Anne, before each daily session the experimenter conducted a MSWO to identify a hierarchy of reinforcers to use during the putative reinforcer trials.

Putative tangible procedures. During the putative tangible treatment analysis trial, access to preferred items was accessed by exceeding baseline levels of MVPA through conditioned, token reinforcement in the form of points. Points were earned by engaging in six consecutive seconds of MVPA. A point was signaled by the sound of the bell and the experimenter announced the cumulated point total. To determine the quality of tangible item earned, the experimenter calculated average points during the baseline period.

At the start of the putative tangible trials, the experimenter provided the participant with the rules. The experimenter stated *"It is time to play on the playground. When I see you run, jump, or climb for six seconds, you will hear the bell* [the bell rang]. *Remember each time you hear the bell, you will earn a point. The more points you earn the better the toy you will earn at the end".* The experimenter then stated the high-preferred items identified during the preference assessment. For example, the experimenter would state, "*Anders, you are a working for the whistle, or the window cling toy. If you earn more than eight points, you will earn the whistle, or the window cling toy"*

High-preferred items were earned if the participant earned more than 175% above the average points by engaging in MVPA established during the baseline trials. Low-preferred items were earned by the participant earning at least 125% above the average points earned by engaging in MVPA established during the baseline trials. Moderately-preferred items were earned by the participant earning between 126% and 174% above the average points earned by engaging in MVPA established during the baseline trials.

Putative interactive attention procedures. During the putative interactive attention treatment analysis trials, the experimenter provided interactive attention in the form of playing with the child in the play they were engaged in for six consecutive seconds while describing the play. For example, if the participant was engaging in running across the playground for six consecutive seconds, the experimenter would immediately describe the play and run along with the participant and engage in other types of play in which MVPA was subsequently observed. However, if the participant ceased in engaging in MVPA (i.e., slow/easy movements, or sedentary activity), the experimenter would cease engaging in the play and providing descriptions of the play. No other attention was provided to the participant during the putative interactive attention trials except for a reminder of the condition rules at the three-minute mark of the six-minute trial.

Arbitrarily-selected Rewards (ASR). ASR trials replicated procedures described in Hustyi and colleagues (2011) which included goal setting, performance feedback, and access to arbitrarily-selected stimuli following physical activity, in the form of a grab-bag reward. Rewards in the grab bag were arbitrarily selected by the experimenter. Tangible stimuli included in the grab bag were similar to those used in the stimulus preference assessment, except that the ASRs were not evaluated prior to the tangible trials.

Goal setting included a percentile schedule of reinforcement of 125% above average baseline step performances (Hustyi et al., 2011). Prior to each ASR trial, the experimenter provided the participant with the performance goal based on step count and rules. The experimenter would state the following rule at the beginning of each ASR trial, "*I am going to watch you play for six minutes, but I can't play or talk to you while you play. While you play the watch is going to count your steps. If you walk more than* [the goal] *you will pick a toy from the bag* [point to bag]. *You need to walk* [step goal]. *Your goal is on the scoreboard* [point to scoreboard]. *If you need to remember how many steps you need to get a toy, look up at the scoreboard. If you want to see how many steps you took, look at your watch. Ready? Play.*"

The number of steps were posted on a centrally-located scoreboard on the playground within view of the participant. At the end of the six-minute trial, the experimenter then read the pedometer and informed the participant if they had met their performance goal or not. If the participant met the performance goal, the experimenter provided the participant with behavior-specific praise and provided the participant an opportunity to blindly select a toy out of the grab bag (i.e., sticker, pencil, top). If the participant did not meet the performance goal, the participant was provided feedback on the step count difference and encouraged to increase their step count during subsequent trials.

CHAPTER 3

RESULTS

Stimulus Preference

Anders

Two MSWOs were administered to identify preferred topographies of attention prior to each session in which the contingent attention test was implement during the reinforcer analysis. Results suggested that preferred topographies of attention consistently identified behavior-specific praise as the most preferred. Moderately-preferred topographies of attention were clapping and a high-five. The least-preferred topography of attention identified by Anders was a fist bump. Therefore, during each of the contingent attention trials during the reinforcer analysis, behavior-specific praise was provided following 6 consecutive seconds of physical activity.

Results of Anders's MSWO of tangible stimuli suggested that an action figure window cling and toy whistle were consistently Anders's most preferred items while a hand clapper, toy car, and a spinning top were moderately-preferred. Anders's least-preferred items were a toy dinosaur, toy frog, and a party blower. These items were consistently chosen across two MSWOs during the reinforcer analysis and two MSWOs during the treatment analysis.

Ashley

Two MSWOs were administered prior to sessions in which the contingent attention condition was implemented during the reinforcer analysis. Results suggested that high-five and behavior-specific praise were high-preferred, while fist bump and hair tossle were least-preferred. Therefore, during each of the contingent attention trials during the reinforcer analysis, high-five and behavior-specific praise were provided following 6 consecutive seconds of physical activity.

Two additional MSWOs were also administered prior to sessions in which the tangible test trials were implemented. Results suggested stability in preference hierarchy with clapper and toy frog as most-preferred, while the toy car and whistle were moderately-preferred, and the ring and key chain were least-preferred. No additional MSWOs were given during the treatment analysis.

Anne

Four MSWOs were administered prior to sessions in which the contingent attention condition was implemented during the reinforcer analysis. Results suggested that behavior-specific praise and hair tossle as the most-preferred topographies. The least-preferred topographies of attention identified were fist bumps and high-fives. Therefore, during each of the contingent attention trials during the reinforcer analysis, behavior-specific praise or a hair tossle was provided following 6 consecutive seconds of physical activity.

Three MSWOs to identify preferred tangible stimuli were administered prior to each session in which a tangible test condition was implemented during the reinforcer analysis. Results suggested that the whistle and top were the most-preferred, while a toy frog and party blower were moderately-preferred. The least-preferred items identified were the clapper and toy car. Two additional MSWOs to determine preferred tangible stimuli were administered prior to each session in which the tangible test condition was administered during the treatment analysis. Results suggested that Anne's preferences changed.

Physical Activity

Anders

During Phase I (Baseline), Anders walked an average of 297.25 m across four baseline trials. Anders's baseline performance (see *Figure 11)* suggested a downward trend in meters walked over time which may indicate that Anders was likely not contacting reinforcement for walking or other physical activity during the baseline. During test conditions in which interactive attention, tangible, and contingent attention were provided as potential reinforcers for distance walked, there appeared to be little differentiation. However, the study was paused for six weeks due to restrictions imposed due to the COVID-19 pandemic at the time of the study.

Following removal of the restriction, baseline trials were once again completed and reestablished. Over three baseline trials, Anders averaged 309.4 m walked which were also below one standard deviations given age and gender norms (Geiger et al., 2007). After baseline was reestablished, test conditions were continued. Initially, meters walked during interactive attention and tangible conditions were well below baseline. However, during the tangible test trials, meters walked increased across the subsequent four trials with an average of 352.4 m walked with an increasing performance trend. Meters walked during the tangible trials were greater compared to the other test conditions. During the attention conditions, Anders walked near or below baseline levels. And, although an increasing trend was also established during the interactive attention, meters walked began to decrease over time. Therefore, it would appear that access to preferred-tangible items were identified as a reinforcer for physical activity in the form of walking.

Results of the reinforcer analysis were then used to inform the putative reinforcer to be used in the treatment analysis (Phase III) in which there was a comparison of the effectiveness of the reinforcer identified during the reinforcer analysis (Phase II) to ASRs (Hyusti et al., 2011). For Anders, access to preferred tangible items was used as the putative reinforcer. Percentage of MVPA observed during the six-minute trials was the primary dependent variable used in decision-making during the treatment analysis. Following a five-trial baseline period, Anders engaged in MVPA for an average of 15.3% of trials. For Anders, the primary topographies of MVPA were running and climbing various playground equipment.

Following baseline, Anders was exposed to the putative reinforcer which was established to be access to specific tangible items identified by stimulus preference assessment. Items that Anders identified as preferred included a toy whistle, window cling toy, and toy dinosaurs. During the first phase of the putative reinforcer condition, Anders engaged in greater rates of MVPA compared to baseline (*Figure 12)* Anders engaged in MVPA for an average of 25.3% across three trials which is an increase of 10%. Following the putative reinforcer trials, Anders was then exposed to ASR described by Hyusti et al. (2011) which included goal-setting, visual display, and access to arbitrary tangible items for meeting or exceeding 125% of baseline. During the ASR trials, Anders' MVPA quickly reduced to rates below baseline to an average of approximately 6% of the trials.

A reversal was then implement in which baseline trials were completed to reestablish goals for both the putative reinforcement and ASR trials. Anders engaged in an average of MVPA of approximately 9% of the trials with a steep decreasing trend. Following the second baseline phase, the putative reinforcer was implemented once again across three subsequent trials. Once again, the percentage of MVPA was greater during the putative reinforcer trials compared to baseline with an average of 21.7% of trials. ASR trials were then implemented once again following the putative reinforcement trials. After an initial trial in which MVPA was observed for 15% of the trial, MVPA quickly decreased to about 3% and to 0%. Results of the treatment analysis of MVPA for Anders identified that the putative reinforcer (that included immediate conditioned reinforcement in the form of bell-ringing and points earned for MVPA that correlated to access to preferred items after each six-minute trials) occasioned greater rates of MVPA compared to ASRs and the baseline.

Ashley

During the reinforcer analysis for Ashley, five baseline trials were conducted to determine inclusion into the current study. Results of the baseline suggested a steady, then steep downward trend in meters walked (see *Figure 13*). Across five baseline trials, Ashley averaged approximately 450 m walked. After baseline established Ashley's inclusion into the current study, reinforcer analysis test trials (Phase II) were conducted using an alternating treatments design. Meters walked during tangible trials suggested a steady, downward trend with an average of 476 m walked across three trials. While meters walked during the attention condition were initially high (497.6 m) relative to the average baseline and all tangible trials, meters walked quickly reduced to 440.6 m (Trial 7), and 368.2 m (Trial 11) with an average of 435.7 m which was below that of baseline. Ashley's performance during the interactive attention condition, as measured by meters walked, appeared to be more stable than baseline and greater than other test trials with an average of approximately 429 m walked. Although Ashley's average performance was slightly less than what was established during baseline, her performance was more stable with meters walked ranging between 452.1 m and 404 m. Therefore, interactive attention was identified as the putative reinforcer during the subsequent treatment analysis (Phase III).

After interactive attention was determined to be the putative reinforcer for physical activity as identified by the reinforcer analysis, baseline rates of MVPA were established during the treatment analysis. For Ashley, MVPA the primary topographies of MVPA observed included running and skipping. During baseline, a steep decreasing trend in MVPA was observed. With initial rates of MVPA at 9.8% and 10.5%, rates of MVPA quickly reduced to 1.6% during the third trial. Following the baseline trials, ASR trials for MVPA was implemented during Trials 4, 5, and 6. Results suggested that MVPA were slightly improved compared to baseline with an average of 7.5% across the three trials with a downward trend. The drop in MVPA following the initial ASR trial suggests that Ashley's MVPA likely did not contact reinforcement which negatively affected performance. However, during the putative reinforcer trials in which interactive attention which was established as a reinforcer, rates of MVPA increased above rates observed during both the baseline and ASR trials (*Figure 14*) An increasing trend of MVPA was observed across three consecutive trials with an average of 12.7% MVPA observed.

Baseline was then reintroduced following a six-week pause in the study due to the COVID-19 pandemic. Baseline rates of MVPA also suggested a downward trend in MVPA across three consecutive trials with an initial rate of 10% of MVPA observed down to 1.7% during Trial 3. Average performance during baseline indicated that Ashley engaged in MVPA for approximately 6% of the trials. Following the second baseline, Ashley was again exposed to the putative reinforcer of interactive attention. Rates of MVPA during the second exposure of the putative reinforcer suggested an increase in MVPA observed with an average of 18.6% intervals in which Ashley engaged in MVPA. Following the putative reinforcer trials, Ashley was exposed to another set of three consecutive ASR trials. During the second set of ASR trials, Ashley engaged in reduced rates of MVPA compared to putative reinforcement trials with an average of 2.8% intervals in which MVPA was observed. These results suggested the putative reinforcer identified by the reinforcer analysis, interactive attention, functioned as a reinforcer of MVPA by increasing rates of MVPA greater than baseline and ASR trials.

Anne

During the reinforcer analysis (*Figure 15*) for Anne, eleven baseline trials were conducted to determine inclusion into the current study. Anne's performance during the baseline trials resulted in an increasing trend across the first seven trials. However, without contacting reinforcement for walking, baseline was established meeting the threshold for inclusion in the study with an average of 428.4 m walked. After baseline was established, test trials were introduced using an alternating treatments design (Phase II).

Initially, the first two trials of the test conditions did not exceed performances established during the baseline. However, following the third exposure to each of the test conditions, differentiation of meters walked across test conditions began to be observed, specifically during the tangible condition. Meters walked during the attention conditions demonstrated a downward trend with an average 372.2 m which suggested that attention did not likely maintain physical activity. Meters walked during the interactive attention condition were consistent across four trials with an average of 378.5 m, but the performance during this particular condition did not exceed the meters walked observed during baseline. Differentiation was observed during the tangible condition after the second tangible trial. During the tangible condition in which Anne identified the whistle and the clapper as the most preferred items, Anne's meters walked exceeded rates observed during baseline and those observed during the other test conditions. Anne's meters walked averaged 495.6 m with a steady upward trend. Anecdotally, the experimenter noted that Anne appeared to engage in greater rates of MVPA in the form of jogging, skipping, and running during the majority of tangible trials. The increased intensity of physical activity was likely influenced by accessing reinforcement in the form of preferred items. For example, Anne would run occasionally to meet or exceed the established meters walked goal stated at the beginning of each trial. The results of the reinforcer analysis indicated that access to preferred-stimuli reinforced and maintained physical activity.

Following the reinforcer analysis, a treatment analysis (Phase III) was completed to compare the effects of the putative reinforcer identified by the reinforcer analysis and ASRs on MVPA (see *Figure 16*). Three baseline trials were first completed. Results of the baseline trials indicated that Anne engaged in MVPA for an average of approximately 2% of intervals. Following baseline trials, Anne was exposed to the ASR trials. Anne's MVPA initially indicated an upward trend in MVPA but after Anne failed to meet or exceed the step count goal established following baseline, MVPA quickly reduced to zero. Across the five ASR trials, Anne engaged in MVPA for an average of approximately 3% of intervals.

During the putative reinforcer trials, Anne's MVPA quickly increased beyond rates of MVPA observed during both the baseline and ASR phases. Anne engaged in MVPA for an average of 17.7% of the intervals during the putative reinforcement trials. These effects were replicated with a second baseline phase in which MVPA was observed for an average of approximately 1% of intervals. Following the second baseline phase, Anne was again exposed to putative reinforcer trials. During these subsequent trials, Anne's rates of MVPA increased and maintained across three trials with an average of 26.1% of intervals observed. The ASRs was then used for three consecutive trials following the putative reinforcer trials. Rates of MVPA observed immediately decreased and maintained at very low rates with MVPA occurring for an average of 1.3% intervals. The results of the treatment analysis suggested that the putative reinforcer identified during the reinforcer analysis increased and maintained MVPA at a greater rate compared to both baseline and ASR trials.

Oxygen Saturation

The oxygen saturation (SpO_2) levels for all participants did not fall below 97%, and did not fluctuate greatly across conditions. Thus, the results indicated that none of the participants were in danger during the duration of the current study. SpO_2 levels below 80% are typically concerned to be dangerous and healthy SpO_2 levels are generally above 89% (Fahy et al., 2011). The results are consistent with prior studies that indicated very little fluctuation of SpO_2 levels across time and activity levels (Lammers et al., 2008; Geiger et al., 2007).

Changes in Heart Rate

Heart rate (HR) was collected using a pulse oximeter during all trials of Phase III. HR was used to monitor each participant's safety as well as changes in physical activity during each trial. However, an additional analysis of HR data was conducted to identify how each condition during Phase III (reinforcer analysis) affected the post-trial HR for each participant. In general, HR should increase as the intensity of physical activity increases. For example, a child's HR should be greater when running compared to when walking.

Recently, Eckard and colleagues (2019) evaluated Heart Rate (HR) as a primary metric to evaluate moderate and vigorous physical activity of four typically-developing, non-obese children. One of the goals of the study was to evaluate if children engaging in physical activity could reach moderate and vigorous HR zones when engaging in various physical activities. The researchers first conducted individual HR assessments of the participants that determined maximum HR (HR_{max}). Next, the Tanaka HR_{max} was used to evaluate changes in HR during activities. The Tanaka HR_{max} is typically used to identify the maximum HR for individuals under 20 years old (Eckard et al., 2019; Tanaka, Monahan, & Seals, 2001). The Tanaka HR_{max} is calculated using the following formula: (208-[0.7 x Chronological Age]). Eckard and colleagues (2019) then calculated two HR zones, moderate activity HR zone, and vigorous activity HR zone. Moderate HR zones were calculated based on the percentage of the Tanaka HRmax by multiplying the Tanaka HR_{max} by 0.65. Vigorous HR zones were calculated by multiplying the Tanaka HR_{max} by 0.85. These activity HR zones are an estimate of the minimum HR levels necessary for behaviors to be considered *exercise* behaviors (Eckard et al., 2019; Physical Activity Guidance Advisory Committee [PAGAC] 2008). In other words, the participant's HR must between 65% and 85% of the Tanaka HR_{max} to be considered exercise behaviors.

Eckard et al. (2019) collected HR on a FT 20s schedule across various physical activity events to calculate HR zones. The researchers then evaluated HR across various levels of physical activity. Activities included walking (moderate activity) and jogging (vigorous activity). Results indicated that the HR change across activities for all four children. These results suggested that HR can be used to evaluate differences in topographies of physical activity (e.g., jogging, running). The procedures also demonstrated that individualized HR zones of physical activity could be identified and used to compare HR changes across activities.

The current study evaluated HR data using a *post-hoc* analysis using similar procedures described by Eckard et al. (2019). A *post* hoc analysis was used given that the current study used observational recoding of MVPA as the primary dependent variable during the treatment analysis (Phase III). Unlike Eckard et al. (2019), the current study calculated MVPA HR range using the post-trial HR rather than the average HR during a physical activity given that the current study only collected pre- and post-trial HR rather than a within-trial method.

The current study used the same formulas described by Eckard et al. (2019) to determine MVPA HR Moderate and vigorous HR zones were combined into one moderate-to-vigorous activity heart rate (MVPA HR) range to better align with observational data collected on physical activity. MVPA HR was calculated by multiplying the Tanaka HR_{max} by 0.65 for the moderate physical activity HR range and multiplying the Tanaka HR_{max} by 0.85 for the vigorous physical activity range. (PAGAC, 2008). These HR zones were combined to one HR zone to better align or compare results with the rate of MVPA observed during Phase III. Therefore the moderate-to-vigorous HR range (MVPA HR) was defined as an individual HR at or above 65% the Tanaka HR_{ma} but below 85% the individual's Tanaka HR_{max} (Eckard et al., 2019).

Table 3 outlines the Tanaka HR_{max} and MVPA HR range for all three participants. No participant's post-trial HR exceeded the Tanaka HR_{max} range during the Phase III treatment analysis. During Phase III, Anders's Tanaka HR_{max} was 205 bpm with a MVPA HR range between 133 and 174 bpm. Anders's post-trial HR was within the MVPA HR range for four trials, or 20% of trials, three of which were during our baseline trials. Post-trial HR was not completed for one baseline trial, however. During ASR trials, post-trial HR was within the MVPA HR range for one trial. Anders's post-trial HR was not within MVPA HR during any of the putative reinforcer trials.

Ashley's Tanaka HR_{max} was 204 bpm with a MVPA HR range between 132 and 173 bpm. For Ashley, post-trial HR was within the MVPA HR range for 12 of the 18 trials of the treatment analysis (Phase III), or 67% of trials. At the end of four baseline trials, Ashley's post-trial HR was within the MVPA HR range. During ASR trials, Ashley's post-trial HR was within MVPA HR range for five trials and within MVPA HR range for three putative reinforcer trials.

Anne's Tanaka HR_{max} was also 204 bpm with a MVPA HR range between 132 and 173 bpm. For Anne, post-trial HR was within MVPA HR range for 3 of the 20 trials of the treatment analysis (Phase III), or 15% of trials. Specifically, post-trial HR was within MVPA HR range for one baseline trial, zero ASR trials, and two putative reinforcer trials.

Results of the *post hoc* HR analysis suggest that a *post hoc* analysis of HR may not yield differentiation across activities. Unlike procedures described by Eckard and colleagues (2019), the current study did not collect HR data within the trial. Eckard et al. (2019) evaluated 20-s block of HR across various intensities of physical activity (i.e., walking, jogging, running) to observe HR change over time. The current study collected HR at the start and end of the trial. The HR used within the current analysis was the post-trial HR. For example, the percentage of MVPA HR across the ASR (17%) and putative reinforcer (28%) trials did not differ compared to baseline (22%). For Anders and Anne, a similar pattern across the conditions was observed

Additionally, the HR zone results did not match the results of the rate of MVPA observed across the ASR, putative reinforcer, or baseline trials. Although greater rates of MVPA were observed during the putative reinforcer trials for all three participants, the percentage of trials in which the participant's post-trial HR was within the MVPA HR zone did not match. The differences between the MVPA observed and the MVPA HR may have been affected by the differences in how HR was collected within the current study.

CHAPTER 4

DISCUSSION

The first goal of the current study was to evaluate procedures that included contingent access to tangible stimuli as a potential class of reinforcer of physical activity. The second aim of the study was to evaluate data from a modified 6MWT as predictive of potential reinforcers of physical activity. Findings were to be used to inform individualized treatments designed to increase the physical activity in young children with obesity. The third aim of the study was to evaluate and compare the effects of putative reinforcers identified by the modified 6MWT (Phase II, reinforcer analysis) versus ASRs commonly used in treatments to increase physical activity in young children (DeLuca & Holborn, 1985, 1990, 1992; Hustyi et al., 2011; Van Camp & Hayes, 2012). The last aim of the current study was to exclusively recruit young children with obesity as participants. Children with obesity have been notably neglected as participants in previous experimental analyses attempting to increase physical activity in children (Larson et al., 2013, 2014; Zerger et al., 2016).

The current study effectively evaluated procedures that included tangible stimuli as a reinforcer class of physical activity in young children with obesity. Previous studies that evaluated procedures to identify reinforcers of physical activity neglected to include tangible stimuli as a potential reinforcer class (Larson et al., 2013, 2014; Zerger et al., 2016). The current study used conditioned reinforcement in the form of a bell to signal points toward contingent access to low-, moderate-, and high-preferred tangible stimuli. A preference hierarchy was identified by stimulus preference assessment that evaluated the relative reinforcing value of specific social (attention and interactive attention) and tangible stimuli. In the tangible condition, reinforcement, using a token economy, was then used to provide immediate reinforcement during the tangible test conditions. Conditioned reinforcement was used because immediate access to tangible stimuli during physical activity may prohibit or interrupt physical activity (DeLeon et al., 2014; Patel et al., 2019). Bell-ringing was conditioned as a reinforcer to provide consequences following physical activity that would not disrupt or prohibit the occurrence of physical activity during the reinforcer analysis. The inclusion of the conditioned reinforcer (i.e., bell ringing) was an effective method of evaluating preferred-tangible stimuli as a potential reinforcer class of physical activity. During Phase II (reinforcer analysis) contingent access to preferred-tangible stimuli was identified as a reinforcer of physical activity for two of the three participants.

The second aim of the study was to evaluate data from a modified 6MWT to predict reinforcer classes increasing physical activity in young children with obesity. Modifications included programmed contingencies for physical activity, repeated measures, and visual analysis of meters walked to determine which contingency increased meters walked. For all three participants, an individualized reinforcer was identified using results from the 6MWT. For Anders and Anne, access to preferred tangible stimuli increased and maintained distance walked compared to baseline and other conditions. For Ashley, interactive attention was identified as a reinforcer of physical activity.

Previous experimental analyses evaluating reinforcers of physical activity failed to identify a reinforcer class for 15.4% of participants (Larson et al., 2013, 2014; Zerger et al., 2016). Inclusion of procedures that evaluate preferred-tangible stimuli as a reinforcer of physical activity can increase treatment efficacy for healthy, nonobese young children as well as those with obesity. Further, evaluating preferred tangible stimuli can help practitioners identify alternative reinforcers relative to sedentary activity in young children with obesity. Identification of reinforcers designed to increase physical activity that compete against sedentary activity is often cited as a major barrier in the treatment of obesity of young children (Carr & Epstein, 2020; Wilfley et al., 2018). The current study has identified procedures that can potentially identify competing reinforcers that provide an alternative to sedentary activity.

Additionally, previous analyses were conducted on an outdoor playground which may not be accessible in certain climates during specific times throughout the year. Further, not at all facilities may have access to playgrounds to replicate procedures described in these studies.

Although the current study used a gymnasium, the procedures used only necessitated access to a 15-m course which may be more accessible than an outdoor playground. The usage of a 15-m course is likely more accessible for most settings compared to outdoor playground space.

The third aim of the study was to evaluate the specificity of reinforcement as it relates to the occurrences of MVPA in young children with obesity. The effect of specificity of reinforcement on the occurrence of MVPA was evaluated during the treatment analysis (Phase III). Results of the current study extended findings from previous studies that have suggested identification of preferred stimuli most often predict functional reinforcers (Kodak et al., 2007; Piazza et al., 1996, 2011). For all three participants, preferred-stimuli, identified by the reinforcer analysis (Phase II) increased the occurrence of MVPA when compared to baseline and contingent access to ASRs during the treatment analysis (Phase III).

During the treatment analysis (Phase III), access to specific tangible stimuli increased the MVPA of two participants; while contingent interactive attention increased the MVPA of the other participant. During ASR trials the occurrences of MVPA decreased for all three participants across trials. For Anne, access to ASRs initially resulted in an increasing trend of MVPA, but quickly fell after Anne failed to meet or exceed the step count goal after three trials. However, during the putative reinforcer trials, in which Anne received access to specific tangible stimuli, the occurrence of MVPA increased and maintained across putative reinforcer trials. For the other participants, the occurrence of MVPA failed to increase to levels observed during the putative reinforcer trials.

Researchers have suggested that non-individualized treatment components, like ASRs, may lack specificity. Omission of such idiosyncrasies may result in treatment failure for children with obesity (Carr & Epstein, 2020; Luttikuis et al., 2009; Nooijan et al., 2017; Wilfley et al., 2018). Thus, if researchers can predict and identify specific reinforcers of physical activity, treatments may be more likely to be successful. The current study demonstrated that the procedures described predicted specific reinforcers increasing physical activity in young children with obesity. The results of the current study provides support for the hypothesis that specificity of reinforcement influences the occurrences of MVPA in young children with obesity.

The fourth aim of the study was to exclusively recruit and include young children with obesity. The current study included only participants with a BMI at or above the 95th percentile. The results of the study are promising in that reinforcers of physical activity and MVPA were predicted and effective by increasing the physical activity of children with obesity. Furthermore, the results may aid practitioners in predicting reinforcers that compete with sedentary behavior. Identifying consequences that reinforce physical activity of young children with obesity is difficult (Carr & Epstein, 2020; Wilfley et al., 2018), especially if sedentary activity appears to have greater reinforcing value compared to physical activity (Epstein et al., 1991; Wing & Phelan, 2005).

While the current study addressed the limitations of previous studies, it should be noted that the current study was conducted during the COVID-19 pandemic. The COVID-19 pandemic caused the experimenter to pause the study for approximately six weeks. It is plausible that the six-week pause may have impacted the results; however, these effects may also be relatively muted given that baseline trials were implemented once restrictions were lifted for two of the three participants who were possibly affected by the pause. For Anders, results of the Phase II (reinforcer analysis) resulted in the differentiation during the tangible condition. Preferred-tangible stimuli were then used as a putative reinforcer during Phase III. During Phase III (treatment analysis), MVPA was greater than baseline and ASR trials and maintained across trials. Anders's results demonstrated that the effects of COVID-19 may not have necessarily impacted the results. The usage of single-subject designs and visual analysis of the data, allowed the experimenter to evaluate changes in distance walked while Anders was exposed to repeated conditions over time. The exposure of repeated conditions may have resulted in changes preference rather than from six week delay due to the occurrence of the COVID-19 pandemic, as evidenced by the changes in meters walked across all conditions.

Ashley's participation in the current study was also affected by the occurrence of the COVID-19 pandemic. However, the effects of the mandatory pause of the study during the COVID-19 pandemic appear to also be relatively muted. Once restrictions were lifted, the study continued by repeating baseline, followed by the putative reinforcer and ASR trials. Ashley's results demonstrated that the putative reinforcer continued to increase and maintain the occurrence of MVPA compared to baseline and ASR trials. These results suggest that the delay due to COVID-19 had little influence on her performance.

Limitations and Future Research

Although the current study addressed the limitations of previous experimental analyses of physical activity and predicted reinforcers that resulted in increased physical activity in young children with obesity compared to ASRs, there were six limitations that should be discussed. First, there were differences in the schedules of reinforcement during Phase III (treatment analysis) between the putative reinforcer and ASR trials which may have confounded the results of the study. During the putative reinforcer trials, reinforcement was provided following six consecutive seconds of MVPA. During putative reinforcer trials in which attention was the reinforcer, the participant was provided immediate attention. During the tangible trials, a conditioned reinforcer (e.g., bell-ringing and points earned) was provided immediately following six consecutive seconds of MVPA, and access to a preferred items was provided at the end of the trial if performance goals were met or exceeded. In contrast, reinforcement was only provided at the end of the six-minute trial during the ASR trials if the participant met or exceeded the performance goal established during baseline. A richer schedule of reinforcement was established during putative reinforcement trials which may have resulted in greater responding during putative reinforcer trials compared to ASR trials.

Future research should identify procedural changes to the current study to equalize the schedules of reinforcement. For example, during the ASR trials, the experimenter could provide a general praise statement that follow six-second bouts of physical activity by stating how many steps the participant as taken (e.g., *"You have taken 100 steps so far."*). Providing performance feedback more rapidly could provide similar schedules of reinforcement to determine if results from the current study were influenced by a putative reinforcer or were due to differences in the reinforcement schedules across conditions.

Future studies could also include trials using rewards that were not identified as reinforcers by the reinforcer analysis (Phase II). For example, the results of the current study suggested that physical activity increased and was maintained by access to preferred-tangible stimuli for Anders and Anne. To evaluate the effectiveness of the specificity of reinforcement, researchers could compare the occurrence of physical activity during tangible and contingent attention conditions during Phase III (treatment analysis).

Second, the schedules of reinforcement within the current study were richer than those in the participant's natural environment. Although providing reinforcement on a FT 6-s schedule could be established, it may be difficult to implement in some settings (i.e., large physical education class). Additional research should be done to replicate the current procedures and include examination of schedule thinning. Increasing the latency between periods in which reinforcement is to be delivered could increase the clinical utility of the procedures. To evaluate schedule thinning of putative reinforcers on the physical activity of young children with obesity, future studies may replicate procedures described in the current study and add additional trials in which schedules of reinforcement are thinned following the identification of the putative reinforcer. For example, in the current study participants accessed reinforcement on a FT 6s. Future studies may assess the effects of other, thinner fixed-time schedules of reinforcement on the physical activity of children with obesity.

A third limitation of the study is that, in spite of predicting reinforcers to increase physical activity of young children with obesity, the cumulative bouts of physical activity during the putative reinforcer trials still remained much lower than the 60 daily minutes recommended by the CDC (2018). For example, Anders had averaged 24% of intervals in which MVPA was observed during the putative reinforcer trials which approximates to a cumulative of 86 seconds of MVPA. Across all putative reinforcer trials during the Phase III (treatment analysis) he engaged in about nine minutes of MVPA. For Ashley, MVPA was observed for an average of 16% of intervals which approximates to 56 seconds. Across all putative reinforcer trials she engaged in about 6 cumulative minutes of MVPA. Finally, for Anne, MVPA was observed for an average of 22% of intervals which approximates to about 79 seconds. Across all putative reinforcement trials she engaged in about eight cumulative minutes of MVPA. Therefore, each participant would need more frequent opportunities under such conditions to engage in MVPA in order to meet the daily recommendation of 60 minutes (CDC, 2018).

In spite of relatively low cumulative bouts of MVPA, there is research that suggests that frequent, yet short bouts of MVPA can aid in reducing BMI in young children with obesity (Holman, Carson, & Janssen, 2011; Willis et al., 2015). Further, if engaging in MVPA can be taught over time through identifying individualized reinforcers and making access contingent on MVPA, perhaps bouts of MVPA could increase over time, thereby establishing a healthier lifestyle that could be sustained over time (Carr & Epstein, 2020; Wilfley et al., 2018; Willis et al., 2015). Future research could extend the current study be replicating the procedures described and continuing to implement treatment (i.e., delivery of putative reinforcers) over time to evaluate if cumulative bouts of MVPA increase.

The fourth limitation of the study was the time requirement needed to implement the current procedures to predict and evaluate reinforcers of physical activity. For example, during Phase II (reinforcer analysis) an average of 21 trials were conducted across all participants (range 14 to 26). With each trial requiring at a minimum of six minutes to complete. The average total time to complete the reinforcer analysis was approximately two hours (126 minutes), which may be time-prohibitive in applied clinical settings.

Future studies should evaluate modifications to Phase II to decrease administration time. If administration time can be reduced, are more likely to be used by more clinicians and practitioners. For example, researchers could use brief experimental analysis methodology in which an adapted alternating treatments design is used to evaluate the effect of an independent variable on the target behavior (Eckert, Ardoin, Daisey, & Scarola, 2000). Applied to physical activity, the experimenter could begin with one baseline trial and then alternate across the three test conditions (e.g., attention, interactive attention, and tangible) to determine each conditions' effect on distance walked during the 6MWT. By using a brief experimental analysis, the administration could be reduced from 126 minutes to about 30 minutes; thus increasing the clinical utility of the procedures described within the current study.

The fifth limitation of the study relates to the length of the 6MWT course. The current study used a different 6MWT course length than Geiger and colleagues (2007) and those described by the ATS (2002). The experimenter did not have access to either a 100-m (ATS, 2002) or 20-m course (Geiger et al., 2007) that would fit within the frame of a fixed-camera. Cacau et al. (2016) conducted an analysis of twelve studies that used the 6MWT procedures which included children and found that studies often used a variety of distances between 15 m to 50 m. Access to 100-m, 50-m, and 20-m courses can be difficult to find in clinical setting (Cacau et al., 2016; Geiger et al., 2007), and the current study is another example of such difficulty. Despite the various course lengths cited in studies the use the 6MWT, the effects of course length on distance walked have not yet been evaluated. Research should evaluate the effects of distance walked when different course lengths are used. Evaluating whether differential lengths of courses using the 6MWT impact distance walked could also improve normative data and increase uniformity of the procedure across settings.

Lastly, because the current study did not evaluate HR as the primary dependent variable, procedures may not have adequately evaluated HR as a potential decision-making variable to determine reinforcers of physical activity. Evaluating post-trial HR may have been problematic given that the rate of MVPA would decrease as the trial ended, or soon following the ASR or tangible putative reinforcer goal was achieved. Unlike procedures described by Eckard and colleagues (2019), the current study did not collect HR data within the trial, but at the end. Eckard et al. (2019) evaluated 20-s block of HR across various intensities of physical activity (i.e., walking, jogging, running) to observe HR change over time. Future studies that include HR as a dependent variable should regularly collect HR within the session to more accurately evaluated HR change as physical activity is observed. Future studies should also replicate the procedures described by Eckard et al. (2019) to evaluate if MVPA HR zones match occurrences of MVPA during a reinforcer analysis of physical activity like the one described in the current study.

Conclusion

Despite the limitations, the current study demonstrated that a reinforcer analysis using data from a modified 6MWT was able to predict a specific reinforcer class. Furthermore, by predicting a specific and individualized reinforcer class, the study demonstrated that specificity of reinforcement can increase greater rates of MVPA when compared to both baseline (no contingent reinforcement) and ASR trials. Finally, the study recruited young children with a BMI at or greater than the 95th percentile. Exclusively recruiting young children with obesity to the current study had not been established in any earlier research on increasing physical activity. The results of the study demonstrated that predicting and identifying specific and individualized classes of reinforcers may aid to improve physical health and reduce treatment failures for children with obesity. The importance of using children with obesity in the current study cannot be understated as improved treatments for this group may produce significant lifelong physical and social benefits.

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TABLE 1

Table 1.

Observational System for Recording Physical Activity in Children (OSRPA-C) used during Phase III. Adapted from McIver et al., 2009.

Level	Activity	Operational Definition
1	Stationary or motionless	Stationary or motionless with no major limb movements or major joint movement (e.g., sleeping, standing).
2	Stationary with limb or trunk movements	Stationary with easy movements of limbs or trunk without translocation (e.g., standing up, holding a moderately heavy object).
3	Slow, easy movements	Translocation at a slow and easy pace (e.g., walking with translocation of both feet, slow cycling).
4	Moderate movements	Translocation at a moderate pace (e.g., walking uphill, two repetitions of skipping or jumping).
5	Vigorous movements	Translocation at a fast or very fast pace (e.g., running)

Note. *Levels 1 and 2 will be collapsed and scored as sedentary activity. Level 3 will be scored as slow/easy activity. Levels 4 and 5 will be collapsed and be scored as moderate-to-vigorous physical activity (MVPA; Larson et al., 2011; Hustyi et al., 2011; Hustyi et al., 2012; Larson et al., 2013; 2014; Zerger et al., 2016; Boga & Normand, 2017).*

TABLE 2

Table 2.

Summary of results of experimental analyses of physical activity published by Larson and colleagues (2013, 2014) and Zerger and colleagues (2016).

Experimental Condition	Percentage of Participants
Contingent attention	38.5%
Interactive play	15.3%
Contingent attention and interactive play	30.8%
Undifferentiated	15.4%
Alone	0%
Escape	0%
Total Participants	**13**

TABLE 3

Table 3.

Percentage of trials in which moderate-to-vigorous heart rate was observed per experimental condition during treatment analysis (Phase III).

Participant	Tanaka HR_{max} (MVPA HR range)	Baseline trials	Putative Reinforcer trials	ASR trials
Anders	205 (133 to 174)	15%	0%	5%
Ashley	204 (132 to 173)	22%	28%	17%
Anne	204 (132 to 173)	5%	10%	0%

FIGURE 1

Figure 1.

Order of experimental phases of the study.

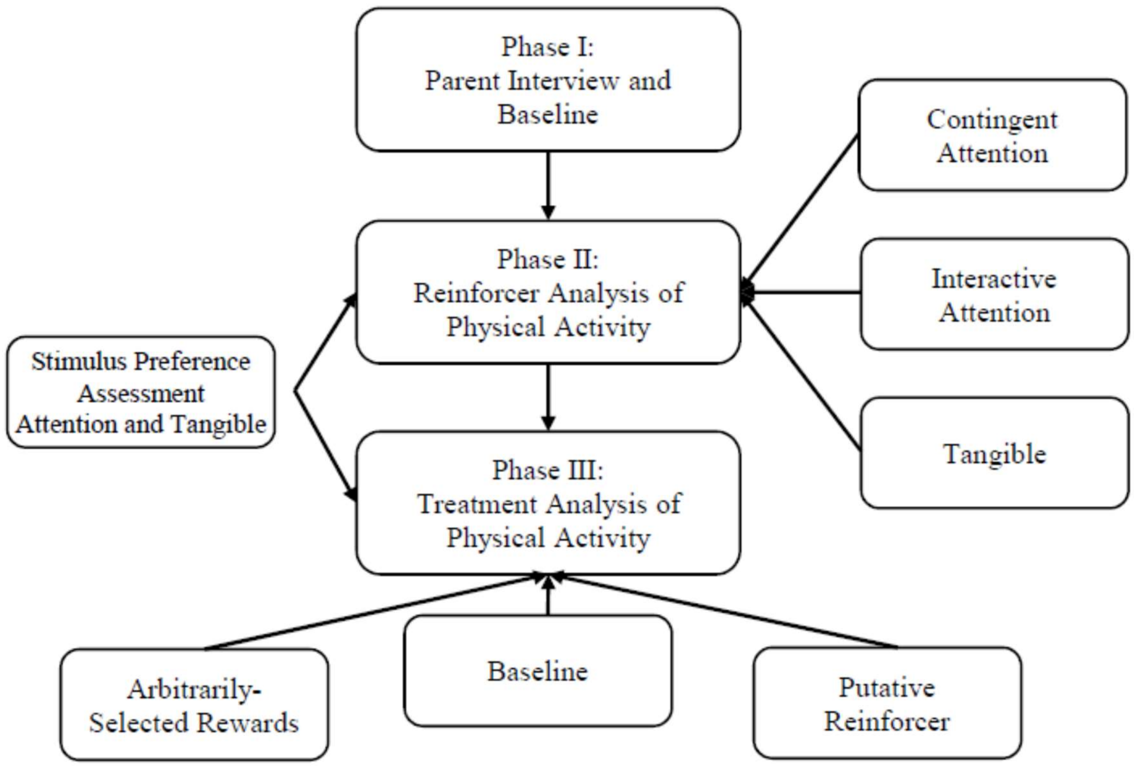

FIGURE 2

Figure 2.

Procedural integrity hand-scoring data collection sheet during the baseline trials using percentage of components implemented accurately during Phase II.

Participant: _____ Date: _______ Trial: ______ Condition: ______ Observer: _______Pri/IOA

Baseline

Procedural Integrity – Six-Minute Walk Test Assessment – Phase II

Assessment Component		Component Completed?	
1	Experimenter collected resting heart rate	YES	NO
2	Experimenter collected oxygen saturation levels	YES	NO
3	Experimenter fitted watch to child's wrist	YES	NO
4	Experimenter walked child to the START line	YES	NO
5	Experimenter reset watch to read ZERO steps	YES	NO
6	Experimenter provided the child with the rules	YES	NO
7	Experimenter ignored the child's attempt to gain attention	YES	NO
8	Experimenter provided a prompt at 3 minutes	YES	NO
9	Experimenter provided a prompt to walk on the blue line if child left the experiment area	YES	NO
10	Experimenter told the child to STOP after six minutes	YES	NO
11	Experimenter obtained heart rate oxygen saturation levels at the end of the trial	YES	NO
12	Experimenter number of steps at the end of the trial	YES	NO
13	Experimenter used the measuring wheel to measure how the child is away from the next 15 m cone	YES	NO
14	Experimenter recorded heart rate, oxygen saturation, and meter data on worksheet	YES	NO
15	Experimenter tracked 15 m lengths walked	YES	NO
16	Experimenter reset measuring wheel to ZERO before subsequent trial	YES	NO
	TOTAL		
	TOTAL OBSERVED		
	PERCENTAGE of components implemented correctly		

FIGURE 3

Figure 3.

Procedural integrity hand-scoring data collection sheet during the contingent attention test condition using percentage of components implemented accurately during Phase II.

Participant: _____ Date: _______ Trial: ______ Condition: ______ Observer: ______ Pri/IOA

Attention

Procedural Integrity – Six-Minute Walk Test Assessment – Phase II

Assessment Component		Component Completed?	
1.	Experimenter collected resting heart rate	YES	NO
2.	Experimenter collected oxygen saturation levels	YES	NO
3.	Experimenter fitted watch to child's wrist	YES	NO
4.	Experimenter walked child to the START line	YES	NO
5.	Experimenter reset watch to read ZERO steps	YES	NO
6.	Experimenter stood at the 7.5 m mark		
7.	Experimenter provided the child with the rules *When you walk, I will talk to you. If you do not walk, I will be quiet.*	YES	NO
8.	Experimenter provided child with attention following 6 consecutive seconds of translocation (walking, jogging, skipping, running).	YES	NO
9.	Experimenter ceased providing attention following sedentary activity immediately	YES	NO
10.	Experimenter provided a prompt at 3 minutes	YES	NO
11.	Experimenter provided a prompt to walk on the blue line if child left the experiment area	YES	NO
12.	Experimenter told the child to STOP after six minutes	YES	NO
13.	Experimenter obtained heart rate oxygen saturation levels at the end of the trial	YES	NO
14.	Experimenter number of steps at the end of the trial	YES	NO
15.	Experimenter used the measuring wheel to measure how the child is away from the next 15 m cone	YES	NO
16.	Experimenter recorded heart rate, oxygen saturation, and meter data on worksheet	YES	NO
17.	Experimenter tracked 15 m lengths walked	YES	NO
18.	Experimenter reset measuring wheel to ZERO before subsequent trial	YES	NO
	TOTAL		
	TOTAL OBSERVED		
	PERCENTAGE of components implemented correctly		

FIGURE 4

Figure 4.

Procedural integrity hand-scoring data collection sheet during the interactive attention test condition using percentage of components implemented accurately during Phase II.

Participant: _____ Date: ________ Trial: ______ Condition: ______ Observer: _____ Pri/IOA

Interactive Play/Attention

Procedural Integrity – Six-Minute Walk Test Assessment – Phase II

Assessment Component		Component Completed?	
1.	Experimenter collected resting heart rate	YES	NO
2.	Experimenter collected oxygen saturation levels	YES	NO
3.	Experimenter fitted watch to child's wrist	YES	NO
4.	Experimenter walked child to the START line	YES	NO
5.	Experimenter reset watch to read ZERO steps	YES	NO
6.	Experimenter stood at the 7.5 m mark		
7.	Experimenter provided the child with the rules *When you walk, I will walk and talk next to you. If you do not walk, I will not walk and I will be quiet.*	YES	NO
8.	Experimenter walked and talked with the child following 6 consecutive seconds of translocation (walking, jogging, skipping, running).	YES	NO
9.	Experimenter ceased walking and talking with the child following sedentary activity immediately	YES	NO
10.	Experimenter provided a prompt at 3 minutes	YES	NO
11.	Experimenter provided a prompt to walk on the blue line if child left the experiment area	YES	NO
12.	Experimenter told the child to STOP after six minutes	YES	NO
13.	Experimenter obtained heart rate oxygen saturation levels at the end of the trial	YES	NO
14.	Experimenter number of steps at the end of the trial	YES	NO
15.	Experimenter used the measuring wheel to measure how the child is away from the next 15 m cone	YES	NO
16.	Experimenter recorded heart rate, oxygen saturation, and meter data on worksheet	YES	NO
17.	Experimenter tracked 15 m lengths walked	YES	NO
18.	Experimenter reset measuring wheel to ZERO before subsequent trial	YES	NO
	TOTAL		
	TOTAL OBSERVED		
	PERCENTAGE of components implemented correctly		

FIGURE 5

Figure 5.

Procedural integrity hand-scoring data collection sheet during the tangible test condition using percentage of components implemented accurately during Phase II.

Participant: _____ Date: _______ Trial: ______ Condition: ______ Observer: ____Pri/IOA

Tangible

Procedural Integrity – Six-Minute Walk Test Assessment – Phase II

Assessment Component		Component Completed?	
1.	Experimenter collected resting heart rate	YES	NO
2.	Experimenter collected oxygen saturation levels	YES	NO
3.	Experimenter fitted watch to child's wrist	YES	NO
4.	Experimenter walked child to the START line	YES	NO
5.	Experimenter reset watch to read ZERO steps	YES	NO
6.	Experimenter implemented teaching trials 1. Walked with the child for 5 m 2. Rang bell 3. Told child that they earned one point 4. Provided the child with low preferred item 5. Walked with the child for 5 more meters 6. Rang bell 7. Told the child they earned another point 8. Provided child with mod. preferred item 9. Walked with the child for 5 more meters 10. Rang bell 11. Told child they earned another point 12. Provided child with most pref. item	YES	NO
7.	Experimenter provided the child with the rules *More you walk, the more times you will hear the bell. The more times you hear the bell, the more points you earn. The more points you earn, the better your toy will be at the end.*	YES	NO
8.	Experimenter rang the bell after every six consecutive seconds of translocation	YES	NO
9.	Experimenter refrained from ringing the bell when child was stationary or engaging in sedentary behavior	YES	NO
10.	Experimenter provided a prompt at 3 minutes	YES	NO
11.	Experimenter provided a prompt to walk on the blue line if child left the experiment area	YES	NO
12.	Experimenter told the child to STOP after six minutes	YES	NO
13.	Experimenter obtained heart rate oxygen saturation levels at the end of the trial	YES	NO
14.	Experimenter number of steps at the end of the trial	YES	NO
15.	Experimenter used the measuring wheel to measure how the child is away from the next 15 m cone	YES	NO
16.	Experimenter recorded heart rate, oxygen saturation, and meter data on worksheet	YES	NO
17.	Experimenter tracked 15 m lengths walked	YES	NO
18.	Experimenter reset measuring wheel to ZERO before subsequent trial	YES	NO
	TOTAL		
	TOTAL OBSERVED		
	PERCENTAGE of components implemented correctly		

FIGURE 6

Figure 6.

Procedural integrity hand-scoring data collection sheet during the baseline trials using percentage of components implemented accurately during Phase III.

Participant: _____ Date: _________ Trial: ______ Condition: ______ Observer: ______ Pri/IOA

Baseline

Procedural Integrity – Treatment Comparison – Phase III

Assessment Component		Component Completed?	
1.	Experimenter collected resting heart rate	YES	NO
2.	Experimenter collected oxygen saturation levels	YES	NO
3.	Experimenter fitted watch to child's wrist	YES	NO
4.	Experimenter walked child to the START area	YES	NO
5.	Experimenter reset watch to read ZERO steps	YES	NO
6.	Experimenter provided the child with the rules	YES	NO
7.	Experimenter ignored the child's attempt to gain attention	YES	NO
8.	Experimenter provided a prompt at 3 minutes	YES	NO
9.	Experimenter provided a prompt to walk on the blue line if child left the experiment area	YES	NO
10.	Experimenter told the child to STOP after six minutes	YES	NO
11.	Experimenter obtained heart rate oxygen saturation levels at the end of the trial	YES	NO
12.	Experimenter number of steps at the end of the trial	YES	NO
13.	Experimenter recorded heart rate, oxygen saturation, and meter data on worksheet	YES	NO
	TOTAL		
	TOTAL OBSERVED		
	PERCENTAGE of components implemented correctly		

FIGURE 7

Figure 7.

Procedural integrity hand-scoring data collection sheet during the ASR trials using percentage of components implemented accurately during Phase III.

Participant: _____ Date: ________ Trial: ______ Condition: ______ Observer____Pri/IOA

Arbitrarily-Selected Rewards

Procedural Integrity – Treatment Comparison – Phase III

Assessment Component		Component Completed?	
1	Experimenter collected resting heart rate	YES	NO
2	Experimenter collected oxygen saturation levels	YES	NO
3	Experimenter fitted watch to child's wrist	YES	NO
4	Experimenter walked child to the START area	YES	NO
5	Experimenter reset watch to read ZERO steps	YES	NO
6	Experimenter provided the child with the rules	YES	NO
	Experimenter provided the child with the step goal (average steps during baseline)		
7	Experimenter ignored the child's attempt to gain attention	YES	NO
8	Experimenter provided a prompt at 3 minutes	YES	NO
10	Experimenter told the child to STOP after six minutes	YES	NO
11	Experimenter obtained heart rate at the end of the trial and step count	YES	NO
12	Experimenter obtained oxygen saturation levels at the end of the trial	YES	NO
13	Experimenter recorded heart rate, oxygen saturation, and step count data on worksheet	YES	NO
14	Experimenter reported the total step count to the child	YES	NO
15	Experimenter provided praise and access to grab bag reward ***if child met or exceeded step goal***	YES	NO
16	Experimenter praised effort but did not provide the child with grab bag reward	YES	NO
	TOTAL		
	TOTAL OBSERVED		
	PERCENTAGE of components implemented correctly		

FIGURE 8

Figure 8.

Procedural integrity hand-scoring data collection sheet during the putative reinforcer trials using percentage of components implemented accurately during Phase III.

Participant: _____ Date: _____ Trial: ______ Condition: ______ Observer: ____ Pri/IOA

<u>Putative Reinforcer Treatment (Matched Treatment)</u>

Procedural Integrity – Treatment Comparison – Phase III

Assessment Component		Component Completed?	
1.	Experimenter collected resting heart rate	YES	NO
2.	Experimenter collected oxygen saturation levels	YES	NO
3.	Experimenter fitted watch to child's wrist	YES	NO
4.	Experimenter walked child to the START line	YES	NO
5.	Experimenter reset watch to read ZERO steps	YES	NO
6.	Experimenter provided the child with the rules	YES	NO
7.	Experimenter provided the child with the appropriate reinforcement following six consecutive seconds of translocation	YES	NO
8.	Experimenter ignored the child if the child engaged in sedentary activity	YES	NO
9.	Experimenter provided a prompt at 3 minutes	YES	NO
10.	Experimenter told the child to STOP after six minutes	YES	NO
11.	Experimenter obtained heart rate at the end of the trial and step count	YES	NO
12.	Experimenter obtained oxygen saturation levels at the end of the trial	YES	NO
13.	Experimenter recorded heart rate, oxygen saturation, and step count data on worksheet	YES	NO
	TOTAL		
	TOTAL OBSERVED		
	PERCENTAGE of components implemented correctly		

FIGURE 9

Figure 9.

Hand-scoring data collection sheet for stimulus preference assessment of topographies of social attention (Nuernberger et al.) or tangible stimuli using pictorial MSWO procedures (Heinicke et al., 2016).

PARTICIPANT	Experimenter Primary // IOA
DATE	Session # **TANGIBLE** Trial # **ATTENTION**
STIMULI USED	
A	D
B	E
C	F

Trial 1	Times Selected	Times Presented	Trial 2	Times Selected	Times Presented	Trial 3	Times Selected	Times Presented

STIMULUS	**Total Selected**	**Total Presented**	**PERCENTAGE Selected / Presented**	**RANK**
A				
B				
C				
D				
E				
F				

FIGURE 10

Figure 10.

Physical activity hand-scoring data collection sheet using 3-s momentary-time sampling during Phase III.

NAME:	Session # ________ Condition _______________			Data Collector: ___________ Prim IOA			Date: Time:
Resting Heart Rate			End Trial Heart Rate			Total Steps	

	Minute 1																			
MTS	3	6	9	12	15	18	21	24	27	30	33	36	39	42	45	48	51	54	57	60
MVPA																				
Slow/easy																				
Sedentary																				
App Bx																				
Problem Bx																				
	Minute 2																			
MTS	3	6	9	12	15	18	21	24	27	30	33	36	39	42	45	48	51	54	57	60
MVPA																				
Slow/easy																				
Sedentary																				
App Bx																				
Problem Bx																				
	Minute 3																			
MTS	3	6	9	12	15	18	21	24	27	30	33	36	39	42	45	48	51	54	57	60
MVPA																				
Slow/easy																				
Sedentary																				
App Bx																				
Problem Bx																				
	Minute 4																			
MTS	3	6	9	12	15	18	21	24	27	30	33	36	39	42	45	48	51	54	57	60
MVPA																				
Slow/easy																				
Sedentary																				
App Bx																				
Problem Bx																				
	Minute 5																			
MTS	3	6	9	12	15	18	21	24	27	30	33	36	39	42	45	48	51	54	57	60
MVPA																				
Slow/easy																				
Sedentary																				
App Bx																				
Problem Bx																				

FIGURE 11

Figure 11.

Meters walked per trial for Anders during the reinforcer analysis of physical activity.

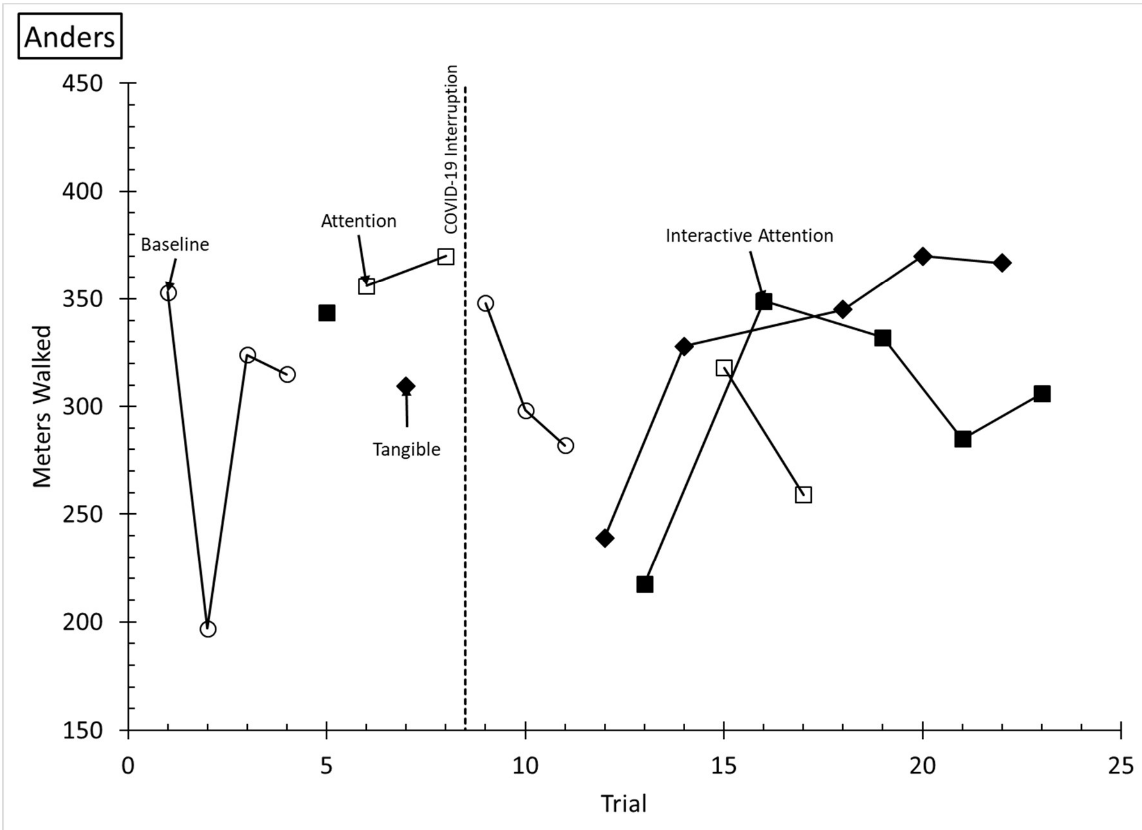

FIGURE 12

Figure 12.

Percentage of intervals with moderate-to-vigorous physical activity per trial for Anders during the treatment analysis.

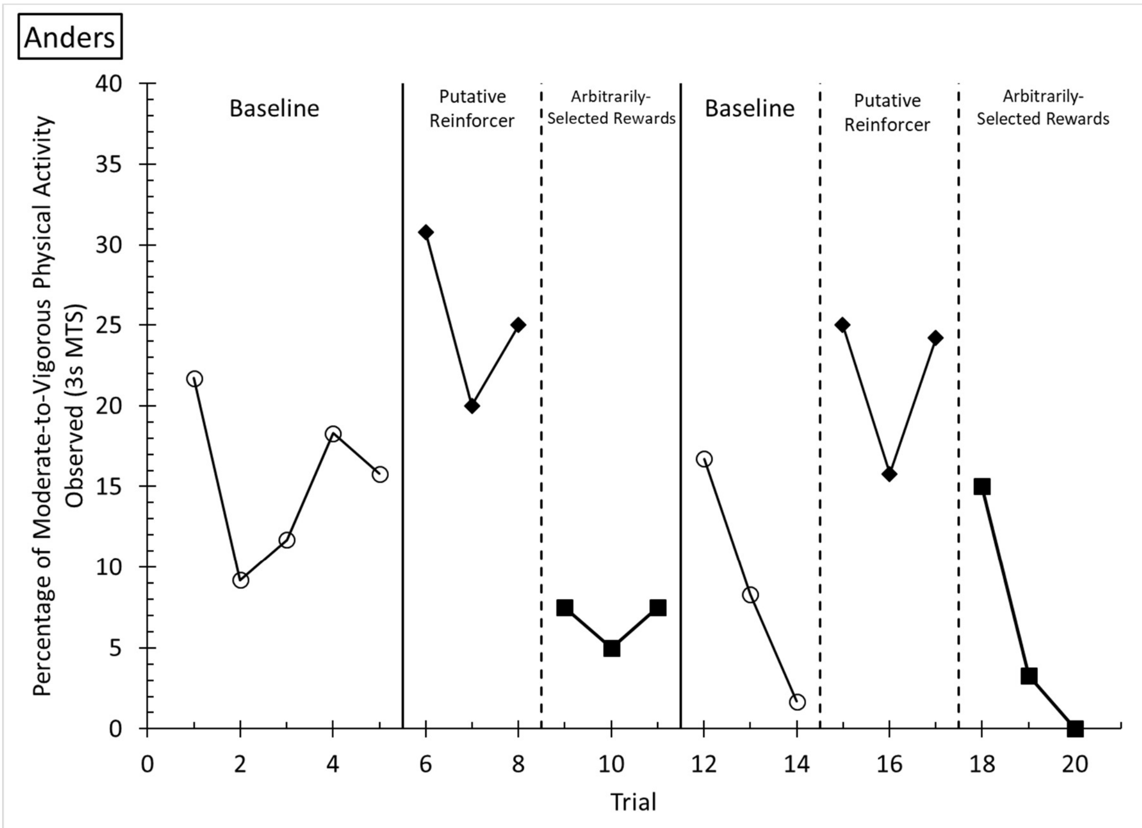

FIGURE 13

Figure 13.

Meters walked per trial during the reinforcer analysis of physical activity for Ashley.

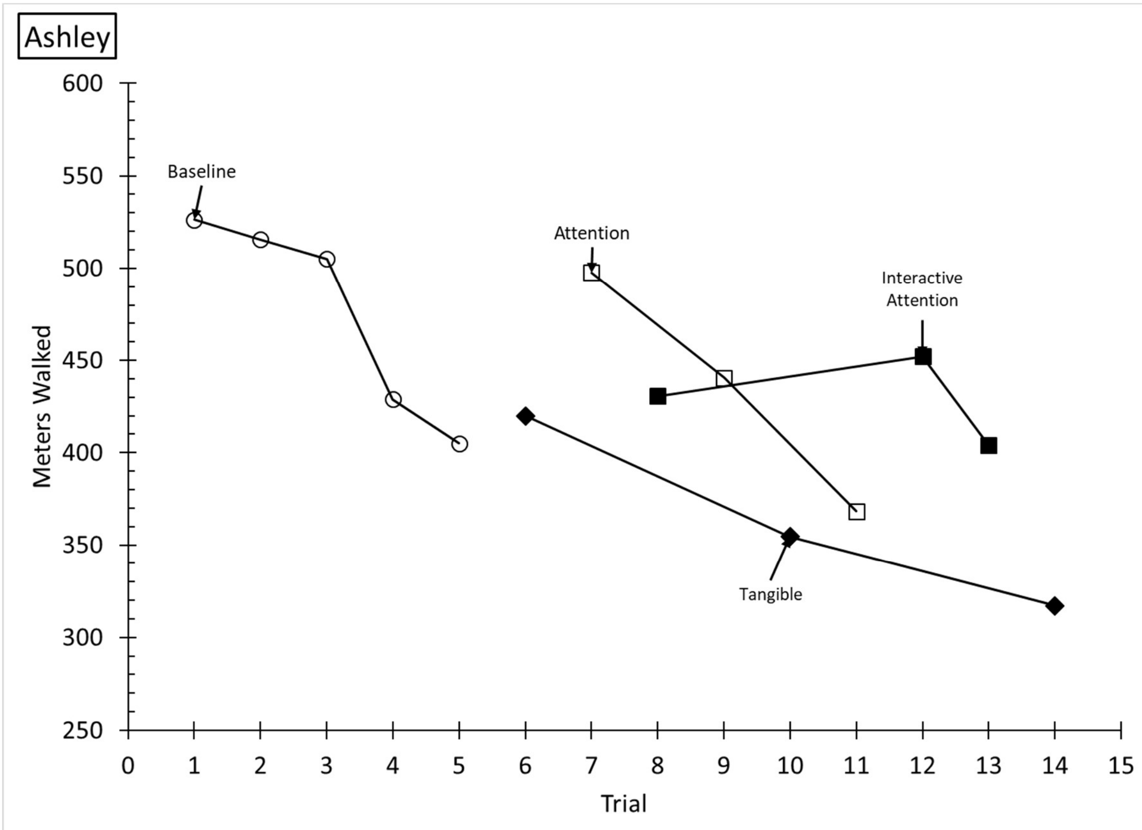

FIGURE 14

Figure 14.

Percentage of intervals with moderate-to-vigorous physical activity per trial for Ashley during the treatment analysis.

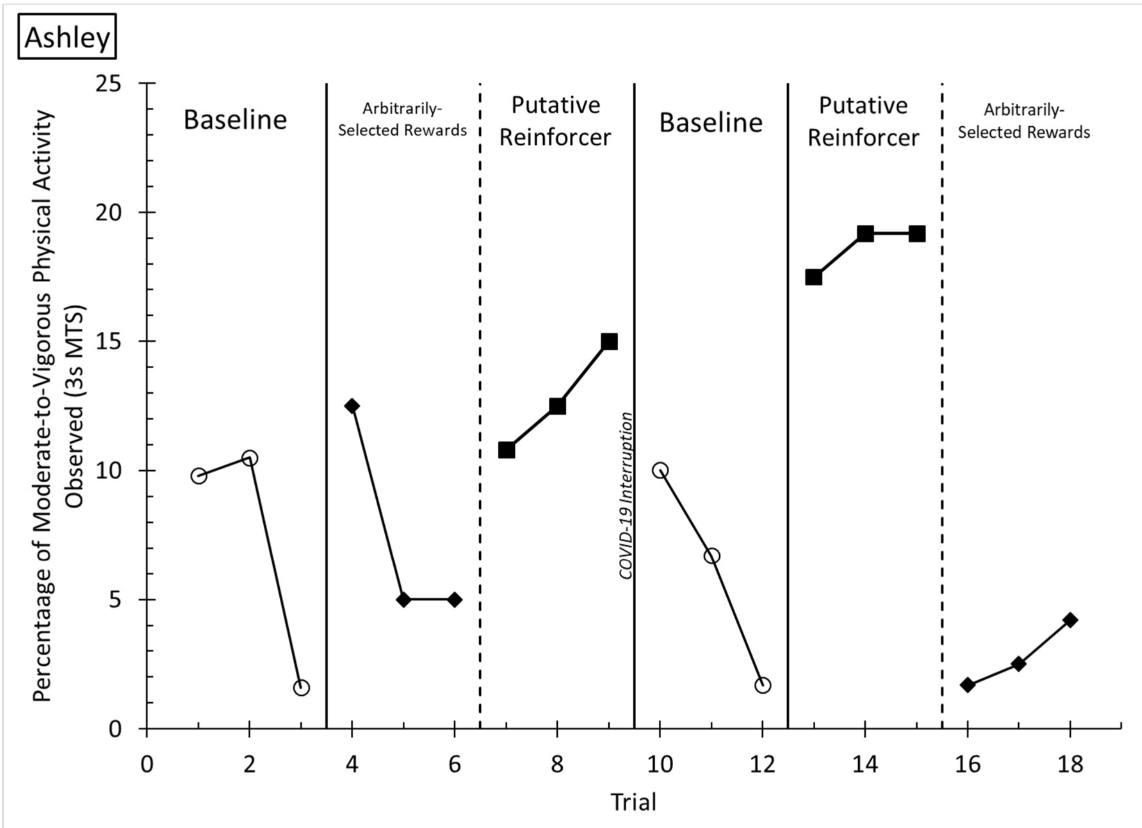

FIGURE 15

Figure 15.

Meters walked per trial during the reinforcer analysis of physical activity for Anne.

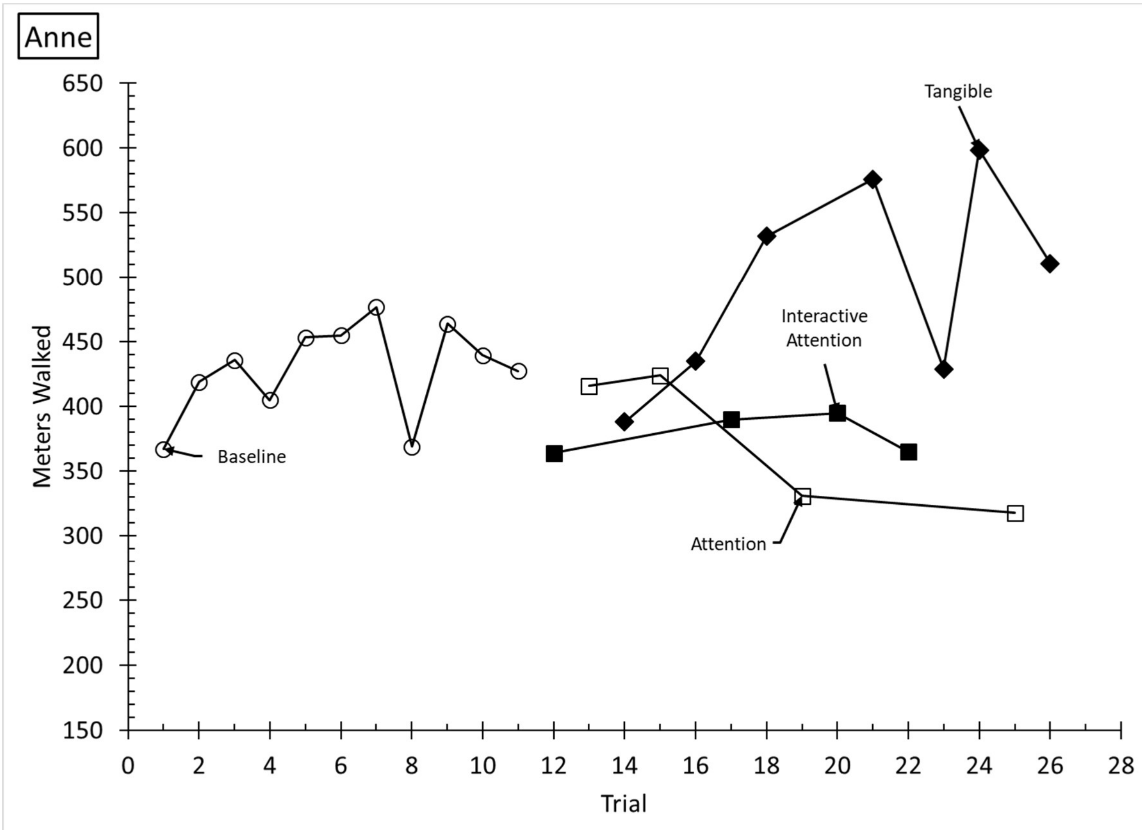

FIGURE 16

Figure 16.

Percentage of intervals with moderate-to-vigorous physical activity per trial for Anne during the treatment analysis.