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The Effect of Token Reinforcement on Moderate-to-Vigorous Physical Activity Exhibited by Young Children

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THE EFFECT OF TOKEN REINFORCEMENT ON MODERATE-TO-VIGOROUS PHYSICAL ACTIVITY EXHIBITED BY YOUNG CHILDREN

by

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DEDICATION

I wholeheartedly dedicate this thesis to my parents, Ramesh and Nita, and to my older brothers, Kratu and Anuj. There are no words to express my gratitude and thanks for their steadfast support.

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The Effect of Token Reinforcement on Moderate-to-Vigorous Physical Activity
Exhibited by Young Children

Abstract

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We used a multiple-baseline across participants and combined reversal and multielement design to assess the effects of contingent-token-reinforcement, compared to noncontingent-token-reinforcement, on moderate-to-vigorous physical activity (MVPA) exhibited by four preschool-aged children. Three children engaged in higher levels of MVPA when tokens were delivered contingent on MVPA compared to baseline (no token) and noncontingent-token conditions. Although MVPA was differentiated across contingent-token sessions and corresponding baseline (no token) control probes for three of the four participants, some variability was apparent. The present study demonstrated that the delivery of tokens contingent on MVPA can increase and maintain MVPA exhibited by preschool-aged children, resulting in more MVPA than in baseline conditions and conditions in which tokens are awarded without respect to MVPA.

Keywords: Physical activity, token reinforcement, conditioned reinforcement, incentives, preschool

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Chapter 1: Introduction and Review of the Literature

Major government and health organizations (American Heart Association [AHA], 2013; Centers for Disease Control and Prevention [CDC], 2015; World Health Organization [WHO], 2010) recommend children engage in at least 60 min of moderate-to-vigorous physical activity (MVPA) every day. Meeting these minimal requirements is associated with healthy development for young children and reduced risk of obesity, noncommunicable diseases, and other health problems, even into adulthood (e.g., CDC, n.d.; Garcia-Aymerich, Lange, Benet, Schnohr, & Antó, 2006; Warburton, Nicol, & Bredin, 2006). Yet, most children in the United States fail to meet these guidelines (Strong et al., 2005; Troiano, Berrigan, Dodd, Masse, Tilert, & McDowell, 2008). This is concerning, given that physical inactivity is the fourth leading risk factor for mortality (WHO, 2010) and is associated with numerous health complications, including high blood pressure, coronary heart disease, depression, and certain types of cancer (AHA, 2013; Johns Hopkins Medicine, 2014; Reilly & Kelly, 2011).

Children who are overweight or obese as preschoolers are five times as likely as normal-weight children to be overweight or obese adults (CDC, 2013; Guo, Wu, Chumlea, & Roche, 2002; Serdula, Ivery, Coates, Freedman, 1993; Singh, Mulder, Twisk, van Mechelen, & Chinapaw, 2008); therefore, the preschool years are a crucial time to identify conditions functionally related to higher levels of physical activity. Two environmental conditions, social positive reinforcement in the form of adult attention and interaction, have been identified as functionally related to elevated levels of MVPA exhibited by young children (Larson, Normand, Morley, & Miller, 2013; Larson, Normand, Morley, & Miller, 2014; Zerger, Normand, Boga, & Patel, 2016). Using functional analysis (FA) methods similar to those first reported by Iwata, Dorsey, Slifer, Bauman, and Richman (1982/1994), researchers have demonstrated that, for children, MVPA consistently increases as a function of contingent adult attention or interaction compared to baseline, control, alone, and escape conditions. However, some results suggest MVPA is not always sensitive to social positive reinforcement contingencies. For example, Zerger et al. (2016) reported that two of the seven participants exhibited undifferentiated responding across all four FA conditions (i.e., control, alone, interactive play, attention) evaluated in the FA. Moreover, even among the five participants who exhibited more MVPA during the two types of social positive reinforcement conditions, two participants engaged in MVPA that was undifferentiated across both conditions during the intervention analysis. Thus, for some children, social consequences might not be functionally related to MVPA, or might not be sufficient to maintain MVPA over time. For these children, providing contingent reinforcement in the form of access to tangibles items might be a more effective way to increase their MVPA.

Hustyi, Normand, and Larson (2011) assessed the effects of a package intervention that included access to tangible items on the step totals and overall activity level of two preschool-aged children who met the body mass index (BMI) criterion for obesity. The package intervention consisted of goal setting and feedback; contingent on meeting or exceeding goals, participants were given access to a prize box consisting of teacher-nominated items (e.g., stickers, stamps, pencils). However, the results were modest: small increases in step totals were observed in the intervention condition compared to baseline for only one participant, and step totals for both participants failed to correspond to the step-total goals. Still, the method and results of Hustyi et al. suggest several avenues to further examine the use of tangibles to increase MVPA in preschool-aged children.

First, unlike previous studies that successfully used social positive reinforcement to increase MVPA exhibited by preschool-aged children (e.g., Larson et al., 2013; Larson et al., 2014; Zerger et al., 2016), Hustyi et al. (2011) did not provide reinforcement contingent on short bouts of MVPA. Instead, children were required to meet a single step total goal by the end of a 20-min session. Preschool-aged children tend to engage in multiple brief bouts of physical activity throughout the day, much shorter than 20 consecutive minutes (CDC, 2008; Ruiz, Tracy, Sommer, & Barkin, 2013), suggesting that shorter experimental sessions might be more developmentally appropriate (e.g., Larson et al., 2013; Larson et al., 2014). Second, because children ages 4 and 5 cannot add larger numbers (Siegler & Braithwaite; 2017), providing feedback about their proximity to the step total goals (Hustyi et al., 2011) also might not have been developmentally suitable. Instead, children might require more frequent consequences, similar to the protocols used by Larson and colleagues demonstrating MVPA exhibited by preschool-aged children increased as a function of contingent social positive reinforcement (Larson et al., 2013; Larson et al., 2014; Zerger et al., 2016). For example, clinicians often deliver tangible reinforcers using an accumulated reinforcement arrangement or token economy to decrease problem behavior and increase desirable, appropriate behavior. This accumulated reinforcement arrangement allows for the immediate delivery of contingent reinforcement (i.e., the token) as well as delayed, but uninterrupted access to the reinforcer at the end of a session (DeLeon et al., 2014).

An accumulated arrangement using tokens (Kazdin, 1982; Kazdin & Bootzin, 1972; see also Hackenberg, 2009) as the immediate consequence for MVPA might be particularly useful for several reasons. First, it would provide access to tangible reinforcement without the need to interrupt sustained bouts of MVPA. Second, behavior might habituate to adult attention and interaction, particularly if the same adult is delivering one or both; tokens allow for the delivery of a variety of tangible reinforcers (e.g., toys, activities, privileges). Third, delivering tangibles might be better for adults who are unable to engage in MVPA with a child because of health concerns or other demands on their time. Fourth, it is possible that attention and interaction with certain adults do not function as reinforcement for some children (e.g., Zerger, et al., 2016), in which case access to tangibles might increase MVPA more than social consequences. Fifth, using tangibles makes it easier to ensure consistent consequences even when multiple adults are working with a child. The quality of praise might also vary among adults, whereas the quality of a tangible is consistent.

An accumulated reinforcement arrangement allows for delayed but uninterrupted access to the reinforce at the end of a session, unlike other arrangements were access to a reinforce is delivered contingent on a target behavior (DeLeon et al., 2014; Hackenberg, 2009). This is important, because provision of tangibles contingent on MVPA can result in frequent interruptions that might result in less continuous engagement in MVPA. Additionally, more time and effort is required on the part of the participant to go back to playing in the session are following each reinforce delivery, which could decreased the likelihood that they do so. In this context, the purpose of the present study was to assess the effects of an accumulated token-reinforcement system on MVPA exhibited by preschool-aged children.

Chapter 2: Methodology

Participants

Four preschool-aged children with no reported intellectual or developmental delays and no reported medical conditions and who attended a local elementary school participated in this study. Parental informed consent and video recording consent forms were obtained for all participants. Parents completed the Physical Activity Readiness-Questionnaire for Children (PAR-Q), a screening tool that asked about basic information regarding general and chronic health as it is related to physical activity. Parents also completed a survey asking them to select from a checklist and to nominate their child's favorite age-appropriate characters from movies (e.g., Star Wars, Finding Dory, Frozen), television shows, or books, as well as small inexpensive tangibles (e.g., squeeze balls, glow sticks). The local institutional review board approved all aspects of this study before recruitment and data collection began.

Setting

All sessions were conducted at a local elementary school, 1 to 5 days per week during times when the playground was otherwise unoccupied. The preschool playground area was fenced and included a fixed-equipment play structure, an open grass area, an open paved area, outdoor toys (e.g., balls, hula hoops, scooters, bikes, etc.), sociodramatic props (e.g., dress clothes and hats, kitchen play set, etc.), and an outdoor table. During sessions, participants had access to the entire playground as they normally would during their recess period. With four exceptions (described under Results), all sessions were 5 min in duration and 1 to 3 sessions were conducted per day, per participant. Prior to and in-between sessions, the primary experimenter asked participants if they needed to use the restroom and wanted a break and to drink water. The total duration of the study was 14 weeks.

Materials

The primary experimenter used a timer to track the duration of each session and wore earphones during both contingent and noncontingent-token conditions. An iPod touch® with prerecorded yoked schedule audio files was used to time the delivery of consequences for all noncontingent-token sessions. Yoked schedule audio files were created using Audacity® in which a 150 Hz tone, 0.5 s in duration, was emitted exactly 0.5 s before a token was to be delivered. For tokens that were delivered at 0 s (i.e., the child earned a token at the start of the session), the tone was placed exactly at 0 s. During both contingent and noncontingent-token conditions, the primary experimenter delivered tokens resembling smiley faces (3 in by 3 in) on a token board (32 in by 40 in) resembling a rocket ship with four different colored and sized sections (i.e., white, red, yellow, and green; see Figure 1). Each color indicated the opportunity to earn a tangible from a similarly colored box (see Token Training below). The tangible item(s) were delivered immediately at the end of each session. A second experimenter recorded all experimental sessions using a digital video recorder mounted on a tripod. Finally, the session order was tracked on a printed sheet that was affixed to a clipboard, for each participant.

Response Measurement and Reliability

MVPA was recorded using the Observational System for Recording Physical Activity, Preschool Version (OSCRAC-P; Brown, Pfeiffer, McIver, Dowda, Almeida, & Pate, 2006). Table 1 summarizes the OSRAC-P activity codes and the corresponding activity topographies. Similar to previous studies (Boga & Normand, 2017; Larson et al., 2013; Larson et al., 2014; Zerger et al., 2016), activity codes 1-3 (i.e., stationary or motionless, stationary with limb or trunk movements, slow easy movements) were combined and scored as "sedentary-to-light physical activity" and activity codes 4 and 5 (i.e., moderate and fast movements) were combined and scored as MVPA. Using video recordings of each session, the duration of MVPA was recorded using a 1-s whole-interval recording method. That is, observers recorded MVPA as a dichotomous variable that either occurred (activity codes 4 and 5) or did not occur (activity codes 1-3) within each 1-s interval. Data were recorded using the InstantData program (Samaha, 2002).

Interobserver agreement (IOA) for percentage of intervals with MVPA was calculated by dividing the number of agreements by the number of agreements plus disagreements for each interval, and multiplying the quotient by 100 to yield a percentage. Agreement on MVPA was defined as two independent observers recording the occurrence or non-occurrence of MVPA during the same 1 s interval. IOA sessions were randomly selected and collected for 29% of baseline sessions, 34.9% of contingent-token sessions, and 46.2% of noncontingent sessions for all participants. Mean agreement across all participants was 92.9% for baseline sessions, 91.7% for contingent-token sessions, and 91.5% for contingent-token sessions. IOA also was calculated for each participant. During baseline sessions, mean agreement was 92% (range, 94.4% to

98.3%) for Amy, 91.4% (range, 91% to 92.3%) for Philip, 93.9% (range, 89.7% to 99%) for Hubert, and 94.4% (range, 91.4% to 100%) for Leela. During contingent-token sessions, mean agreement was 92.7% (range, 84.4% to 99.7%) for Amy, 92.5% (range, 90.4% to 96.7%) for Philip, 91.6% (range, 87.7% to 95.3%) for Hubert, and 89.8% (range, 87.7% to 92.7%) for Leela. During noncontingent-token sessions, mean agreement was 92% (range, 84.4% to 97.7%) for Amy, 89.1% (range, 77.7% to 95.7%) for Philip, 92.5% (range, 87% to 98.6%) for Hubert, and 92.4% (range, 89.4% to 94%) for Leela.

Experimenter and Observer Training

All experimenters and observers were required to meet specific criteria for conducting sessions and recording data, as described below.

Experimenter training. Experimenters were trained following a Behavioral Skills Training (BST) model (e.g., Sarokoff & Sturmey, 2004; Yeaton & Bailey, 1983) that consisted of instruction, modeling, rehearsal, and feedback. First, the trainees reviewed a task analysis that detailed the procedure for the baseline (no token), contingent-token, and noncontingent-token conditions. Trainees were required to score 80% or higher on a multiple-choice quiz about the procedures for all conditions before proceeding to the next step. Second, using a volunteer acting as a participant (i.e., the volunteer engaged in various physical activities on the playground), the trainer modeled primary and secondary experimenter roles in-vivo (i.e., on a playground) for each condition. Third, trainees practiced primary and secondary experimenter roles in each condition on a playground with the volunteer acting as the participant. Fourth, the trainer observed the trainees practice both roles in each condition, and provided immediate feedback (i.e., positive praise for correct responses and corrective feedback for incorrect responses). Trainees practiced until they were able to conduct each condition accurately. That is, during the contingent-token condition, trainees correctly delivered descriptive attention (e.g., You got a token!") and a token (i.e., placed a token on the token board) contingent on MVPA; and during the noncontingent-token condition, trainees correctly delivered descriptive attention and tokens according to a yoked schedule.

Observer training followed the five steps outlined in Cooper, Heron, and Heward (2007). First, observer trainees reviewed operational definitions from the OSRAC-P (Brown et al., 2006) and were provided with specific examples and non-examples of the different activity codes (e.g., walking up a slide is code 4, sitting down and kicking legs is code 2). Trainees were required to score 80% or higher on a multiple-choice quiz covering activity codes and types of physical activities categorized under each code. Those who did not meet the score criterion retook the quiz until criterion was met. Trainees were also provided instructions for operating the program used to record MVPA (i.e., InstantData), followed by a session during which their questions were answered regarding the coding system, operational definitions, specific activities, and InstantData.

Second, trainees coded brief video vignettes of adults engaging in a variety of physical activities on a playground using all five activity codes. Next, they coded brief video vignettes of preschool-aged children engaging in a variety of physical activities on a playground using all five activity codes.

Third, the trainees used InstantData to code longer video vignettes of children on a playground engaging in a range of physical activities using all five activity codes.

Fourth, trainees independently coded MVPA as a dichotomous variable (i.e., codes 4 and 5 were collapsed into a single code indicating MVPA was occurring and codes 1, 2 or 3 were collapsed into a single code indicating MVPA was not occurring) using videos of physical activity FAs from a previous study (i.e., Zerger et al., 2016). Agreement was calculated by comparing each trainee's code with those from previously coded master videos (i.e., exact, second by second account of activity). Trainees were provided graphical feedback of their IOA and were required meet 90% agreement or higher for two consecutive videos. Trainees who did not meet criterion were provided corrective feedback on their codes, and were required to code those same videos until they met criterion. Once criterion was achieved on those videos, trainees were assigned two more novel videos to code. This continued until trainees coded two consecutive novel videos with 90% or higher agreement with coded masters.

Fifth, trainees coded two sessions from the current study and were required to reach at least 90% agreement with two trained observers across two consecutive novel videos. All three trainees met this criterion during the first two videos. After fulfilling the requirements for observer training, trainees became observers and were qualified to code videos during data collection.

Procedure

A multiple-baseline across participants and combined reversal and multielement design was used for this study. In Phase A (baseline), levels of MVPA were assessed without the use of tokens. Phase B consisted of the contingent-token condition and Phase C consisted of the noncontingent-token condition; baseline (no token) probes were also conducted throughout the course of the study. Descriptions of the various experimental conditions are below.

With four exceptions (see Results), all baseline (no token), contingent-token, and noncontingent-token conditions were 5 min in duration. Condition changes did not occur until stability in responding was observed. All experimental conditions were conducted on a preschool playground with the experimenter(s); no staff or peers were present. If the participant attempted to leave the session area, the experimenter used minimal prompting to guide the participant back to the session area (e.g., "Remember, we have to stay on the playground"). If the participant attempted to engage an experimenter in conversation, the experimenter pretended not to hear and to be busy working on a task on her phone. All sessions were video recorded and two experimenters were present except for the baseline conditions, when only the secondary experimenter remained in the session area (see below).

During the first contingent-token condition, all participants approached the primary experimenter to ask to select their prizes when they earned 25 tokens prior to the end of the session. When this occurred, the primary experimenter responded, "We still have some time, play for a little while longer." For Amy, Philip, and Leela this occurred only once and following the primary experimenter's request, they all complied and completed their 5 min sessions. Hubert's behavior was more variable. Hubert earned 25 or more tokens during 16 experimental sessions and asked if he could select his prizes prior to the end of the session, during 11 of those 16 sessions. He asked, "Can I pick a prize now?" on average 3 times per session with a range 1 to 11. For example, during session 26, he asked the primary experimenter 11 times if he could pick a prize with 1 min 11 s of the session remaining.

Baseline (no token). During baseline, the primary experimenter guided the participant to the session area and instructed the participant, "I have to go inside to do some work. Play out here for a little bit." The primary experimenter remained out of sight for the duration of the session. The secondary experimenter remained in the session area to supervise and video record the session. No programmed consequences (e.g., tokens, attention) were delivered contingent on MVPA.

Token training. Once, prior to the start of the first contingent-token session, the primary experimenter taught the participant about the token system using the three steps outlined by Cooper et al. (2007). First, the token system was explained (i.e., tokens and rules for earning and exchanging tokens were defined and described). Second, the experimenter modeled the procedure for token delivery and each participant was encouraged to engage in the specified MVPA required to receive tokens. Third, the experimenter modeled the procedure for token exchange and the participant exchanged the tokens he or she received during the second step.

The rocket ship token board (see Figure 1) had four distinct sections; a bottom section with 1 empty slot, and three sections with 6, 8, and 10 empty slots, respectively, on which the smiley face tokens were placed, contingent on MVPA. Each colored section on the token board corresponded to selecting a prize from one or more similarly colored boxes. The first section, located beneath the rocket ship, was colored white and corresponded to a white box filled with small, simple stickers (e.g., flower, basketball). This section was created to ensure all participants were able to contact reinforcement contingent on one bout of MVPA. If a participant earned 1 to 6 tokens, the participant had the opportunity to select one small, simple sticker. The second section, located at the bottom of the rocket ship, was colored red. If a participant earned 7 to 14 tokens, the participant had the opportunity to select two stickers, one from the white box and one from a selection of new stickers from the red box. The third section, located at the middle of the rocket ship was colored yellow. If a participant earned 15 to 24 tokens, the participant had the opportunity to select two stickers (one from the white box and one from the red box) and one small item from the yellow box. The fourth section, located at the top of the rocket ship was colored green. If a participant earned 25 or more tokens, the participant had the opportunity to select an item from the green box, along with a selection from the previous three boxes (i.e., white, red, yellow boxes). At the end of each contingent-token session, each participant selected a prize or prizes from the box based on the section of the rocket ship that was filled with earned tokens.

After each contingent and noncontingent-token session throughout the study, participants were asked to indicate the box(es) from which he or she could select a prize to verify that they could still describe the token contingencies. When participants made any type of statement about not getting a prize from a certain box (e.g., “I didn’t get a prize from the green box! I want the Goofy figure!”), the primary experimenter asked follow-up questions about the token system. For example, the following sequence of questions was typically asked: “How do you get the Goofy figure from the green box?”, “And how do you get more tokens?”, “Great job, you can try again next time!” Because some participants exceeded 25 tokens in the first contingent-token phase (e.g., Leela earned 47 tokens during her first contingent-token session), more slots for tokens were added to the token board, but the rules for exchanging tokens remained the same (i.e., 25 or more tokens still resulted in access to selecting a prize from each box).

Safety training. During token training, rules for playing safe were put in place (i.e., the primary experimenter stated safe play behaviors, then at the start of each session day, participants were asked to answer, "What does playing safe mean?"), after Hubert engaged in unsafe play by jumping off the top of the fixed-equipment. However, Hubert repeatedly flopped hard onto his knees during his third contingent-token session (between sessions 13 and 14); we terminated that session early at 1 min 14s (one of four sessions that did not reach 5 min) due to unsafe play. Before conducting any additional sessions, we used BST to teach safe play behaviors to all participants during their next scheduled session. Safety training was implemented before the following sessions for each participant: session 15 for Amy, session 13 for Philip, session 14 for Hubert, and session 15 for Leela. The primary experimenter defined safe play to each participant (i.e., the rules of the playground, e.g., top to bottom on the blue slides, no jumping off the fixed-equipment) and the importance of playing safe. The primary experimenter then asked each participant "What does playing safe mean?" and participants were required to correctly recite the rules. Next, the primary experimenter modeled playing safe behaviors (e.g., going up and down the ladder without jumping off from the top). After, the primary experimenter asked the participants to demonstrate safe play behaviors (e.g., "Okay, now you show me how you go down the slide safely." or "Show me how you run safely.") and provided verbal praise and corrective feedback contingent on safe play behaviors.

Contingent token. At the start of every contingent-token condition session, the experimenter stated, “If you run, jump, or climb, you’ll get a token and I’ll put it on this [*point to*] board. The more tokens you get, the more prizes you get! Remember when you get a token, keep playing.” Contingent on MVPA, the experimenter delivered descriptive attention (e.g., “You got a token”) and placed one token on the token board, which was visible to the participant. If the participant continued to engage in MVPA, descriptive attention and a token was delivered every 10 s.

Noncontingent token. During noncontingent-token, the experimenter did not deliver tokens contingent on MVPA. Instead token delivery was yoked to the token delivery during the corresponding contingent-token session for the same participant in the previous condition. That is, timing of token delivery for the first noncontingent-token session was yoked to the timing of token delivery in the first contingent-token session, the timing of token delivery in the second noncontingent-token session was yoked to the timing of token delivery during the second contingent-token session, and so on. The time of token delivery was calculated based on when the primary experimenter uttered the word “you” in the phrase “you got a token.” For example, if during the contingent-token session, the experimenter announced to the participant, “you got a token” and delivered a token at 15 s, 67 s, 148 s, and 272 s, the experimenter would state “you got a token” and deliver a token at each of those times during the yoked noncontingent-token session, irrespective of MVPA. Therefore, participants earned the same number of tokens at the same times in both conditions.

Procedural Integrity

Procedural integrity in the contingent-token condition was defined as two independent observers recording the delivery of descriptive attention ("You got a token!") within 5 s of the initiation of MVPA and recording the same total number of tokens delivered per session. Data were collected for a minimum of one-third of randomly selected sessions per participant. Procedural integrity for the contingent-token condition was collected for 36.5% of sessions, in total, and the mean percentage was 90.9% (range, 81% to 100%) across all participants.

Procedural integrity was calculated 37.5% of sessions for Amy with a mean of 87.9% (range, 81% to 100%), 33.3% of sessions for Philip with a mean of 94.7% (range, 89.3% to 100%), 38.5% of sessions for Hubert with a mean of 89.7% (85.2% to 92.3%), and 37.5% of sessions for Leela with a mean of 91.1% (82.1% to 96.6%). IOA was calculated for 37.5% of sessions for Amy with a mean agreement of 94.8% (range, 80.6% to 100%), 33.3% of sessions for Philip with a mean agreement of 94.7% (range, 90.9% to 100%), 38.5% of sessions for Hubert with a mean agreement of 92.1% (range, 86.7% to 100%), and 36.5% of sessions for Leela with a mean of 88.9% (range, 79.3 to 96%).

Procedural integrity for the noncontingent-token condition was defined as two independent observers recording the delivery of descriptive attention ("You got a token") within 5 s of the predetermined yoked schedule and the total number of tokens delivered per session. Data were calculated for a minimum of one-third of randomly selected sessions per participant. Procedural integrity for the noncontingent-token condition was collected for 35.9% of sessions, in total, and was 100% across all participants. Procedural integrity was calculated for 37.5% sessions for Amy and Philip, 35.3% of sessions for Hubert, and 33.3% of sessions for Leela, and for all participants, IOA was 100%.

Chapter 3: Results

We excluded four sessions from the data analysis because we had to terminate those sessions early. We excluded three sessions for Hubert; between sessions 13 and 14, the primary experimenter terminated a contingent-token session early at 1 min 14 s due to unsafe play, between sessions 20 and 21, Hubert ran into the classroom and wanted to stay inside during a baseline session, and between sessions 38 and 39, the session was terminated at 2 min 14 s because Hubert ran into the classroom during a contingent-token session. We excluded one session for Amy between sessions 16 and 17, after her third statement that she felt "too hot."

Overall, the percentage of intervals with MVPA for three of the four participants (Philip, Hubert, and Leela) was higher during contingent-token conditions compared to baseline (no token), baseline (no token) probes, and noncontingent-token conditions (Figure 2). However, one participant (Amy) exhibited a steady decline in MVPA beginning with the first noncontingent-token condition (Figure 2). MVPA during the baseline probes for Philip, Hubert, and Leela were comparable to those exhibited in the initial baseline phase. Philip's initial baseline condition was steady and the average percentage of intervals with MVPA was 20.3% (range, 19% to 22%) and 16.7% (12% to 30%) during baseline probes. For Hubert and Leela, variable and low baseline levels of MVPA were observed across 9 and 13 sessions, respectively. For Hubert, the average percentage of intervals with MVPA during the initial baseline condition was 17.3% (range, 1% to 31%) and 15.1% (range, 17% to 31%) during baseline probes. For Leela, the average percentage of intervals with MVPA during the initial baseline phase was 11.8% (range, 0% to 32%) and 13.9% (range, 1% to 27%) during baseline probes. In addition, MVPA for Philip, Hubert, and Leela, was differentiated across all contingent-token and baseline sessions. Moreover, MVPA patterns overlapped with baseline conditions only during noncontingent-token conditions, with the exception of contingent-token sessions 10 and 11 for Philip.

For Philip, Hubert, and Leela, the contingent-token phase resulted in higher and less variable levels of MVPA compared to noncontingent-token conditions. Data for Philip and Leela show a similar pattern of responding in the reversal. During the first contingent-token condition, average percentage of intervals with MVPA for Phillip was 38.8% (range, 23% to 46%) and for Leela was 47% (range, 40% to 65%). When the noncontingent-token condition was introduced, levels of MVPA reduced and remained at lower levels; average percentage of intervals with MVPA for Philip was 24.5% (range, 9% to 40%) and for Leela was 18.3% (range, 15% to 29%). For Philip when the contingent-token condition was reintroduced, MVPA increased to levels observed during the first contingent-token phase, an average of 38.2% of intervals (range, 29% to 48%). For Leela, MVPA occurred during an average of 39.5% of intervals (range, 30% to 52%), lower than the first contingent-token condition, but higher than the preceding noncontingent-token condition.

For Hubert, high levels of MVPA were observed during both contingent-token phases (i.e., average MVPA of 48.5% (range, 22% to 58%) and 42.1% (range, 33% to 47%), respectively). However, in contrast to the patterns observed for Philip and Leela during the first noncontingent-token condition, Hubert exhibited a decreasing trend in

MVPA across 13 sessions, for an average of 44.2% (range, 18% to 53%). During the second noncontingent-token condition, a similar decrease was observed, although more quickly compared to the first noncontingent-token phase, for an average of 23.5% (range, 18% to 33%).

For Amy, during the initial baseline phase, MVPA was steady at an average of 26.3% (range, 24% to 29%). The first contingent-token phase resulted in an increase of MVPA to an average of 53.3% (range, 46% to 58%), and the first noncontingent-token phase resulted in a reduction of MVPA to an average of 28.8% (range, 23% to 35%). However, following introduction of the second contingent-token condition, the levels observed during the first contingent-token phase were not recaptured; instead a decreasing trend was evident that continued through the second noncontingent condition and third reversal to the contingent-token condition.

Pearson product-moment correlation coefficients were calculated separately for each condition (i.e., contingent and noncontingent-token) across all participants to assess the association between the percentage of intervals with MVPA and the number of tokens earned during those sessions. For contingent-token sessions, there was a positive correlation ($r = 0.8737$, $p < 0.0001$, $n = 63$). For noncontingent-token sessions, no clear correlation was observed ($r = 0.2294$, $p = 0.1602$, $n = 39$). Figure 3 depicts scatterplots of both contingent and noncontingent-token conditions. Consecutive seconds during which participants engaged in MVPA or bouts, were graphed sequentially to depict duration and frequency of MVPA within and across experimental conditions. Bouts were calculated by adding the number of consecutive 1 s intervals scored as MVPA to assess the length of MVPA bouts. Graphs (visually inspected by the authors of this study but not provided in the manuscript) for each participant showed no difference between conditions for mean bout durations. For all participants, mean bout duration was longer in the contingent-token phases, but only by 1 to 2 sec (see Table 2). More variable patterns of bouts, often characterized by a few outlier bouts (i.e., longer bout durations) were observed in the contingent-token phases compared to the noncontingent-token phases.

Chapter 4: Discussion

The purpose of the current study was to assess the effects of contingent-token reinforcement, compared to noncontingent-token reinforcement, on the MVPA exhibited by four preschool-aged children. Three children engaged in higher levels of MVPA when tokens were delivered contingent on MVPA compared to baseline (no token) and noncontingent-token conditions. Although, MVPA was differentiated across contingent-token sessions and corresponding baseline (no token) control probes for three of the four participants (Philip, Hubert, and Leela), some variability was apparent. One participant (Amy) engaged in high levels of MVPA during the first contingent-token phase, but then MVPA declined to near zero levels across the remaining experimental conditions. For Philip and Leela, an immediate reduction in MVPA was observed following the change to noncontingent-token delivery.

In contrast, Hubert exhibited a gradual decline in MVPA during the noncontingent-token condition, indicative of response persistence, which is often observed in noncontingent reinforcement (NCR)-control procedures (e.g., Bloom & Esposito, 1975; Goetz, Holmberg, & LeBlanc, 1975; Konarski, Johnson, Crowell, & Whitman, 1980; Thompson, Iwata, Hanley, Dozier, & Samaha, 2003). It is possible that some token deliveries during the noncontingent-token condition coincided with the target behavior, resulting in adventitious reinforcement (Thompson & Iwata, 2005; Neuringer, 1970; Skinner, 1948). It is also possible that an intermittent schedule of reinforcement was inadvertently established. The observed pattern also is consistent with operant extinction, which is a behavioral process often implicated for the decreased effects observed during NCR schedules (Hagopian, Fisher, & Legacy, 1994; Vollmer, Iwata, Zarcone, Smith, & Mazaleski, 1993; Vollmer, Marcus, & Ringdahl, 1995). Delivery of tokens during the noncontingent-token condition maintained more features of the reinforcing situation (i.e., contingent-token) compared to a normal extinction procedure, while simultaneously eliminating the response-reinforcer contingency. Because the response-reinforcer contingency was eliminated during the noncontingent-token phase and the frequency of the target response subsequently reduced, observed results could very well be that of an extinction curve (Rescorla & Skucy, 1969). Despite this, two factors contributed to the demonstration of experimental control for Hubert. First, upon reinstating the contingent-token phase, response recovery was immediate and remained stable throughout the condition. Second, the decrease observed in the second noncontingent-token condition occurred more quickly.

Although results of the token system are promising, the data must be considered in the context of several limitations. First, no preference or reinforcer assessments were conducted, so we cannot be certain that the selected prizes functioned as reinforcers. This might be especially true for Amy, for whom an overall reduction to near zero levels of MVPA was observed across conditions beginning with the first noncontingent-token phase. The prizes might not have functioned as reinforcers for Amy, or the prizes might have stopped serving as reinforcers, or served as only very weak reinforcers, as the study progressed. Also, repeated exposure might have resulted in habituation to the prizes (McSweeney, 2004; Murphy, McSweeney, Smith, & McComas, 2003). Competing contingencies also might have played a role; perhaps engaging in MVPA (or participating in the study) was more aversive for Amy than the prizes were reinforcing. Although Amy often vocalized her interest in specific prizes from the green box, and clearly and accurately verbalized the contingencies in place to obtain those prizes, her behavior did not match what she verbalized. This mismatch between verbal self-reports of stimulus value and actual stimulus value based on the operant behavior is not uncommon (Bernstein & Michael, 1990; Northup, 2000; Northup, Jones, Broussard, & Vollmer, 1996; Risley & Hart, 1968), but does highlight the fact that use of a token economy is not a guaranteed intervention, and at times, might not be an effective strategy for increasing MVPA in young children.

Previous studies (Larson et al., 2013; Larson et al., 2014; Zerger et a., 2016) have identified functional relationships between increased MVPA and social positive contingencies (i.e., adult attention, adult interaction) in preschool-aged children when compared to escape and nonsocial (i.e., alone) contingency conditions. Although the contingent-token reinforcement condition did not appear to be effective for Amy, it is possible that other conditions (e.g., contingent adult attention and/or interaction) might have increased and maintained higher levels of MVPA for Amy. Unfortunately, Amy's family moved out of the area before we were able to evaluate the effects of social positive reinforcement in the form of adult interaction on MVPA.

Future researchers should incorporate preference and reinforcer assessments to identify items as reinforcers prior to the start of the study and then periodically throughout the treatment phases (DeLeon & Iwata, 1996). Concurrent-schedule arrangements also can be used to test for relative reinforcer effectiveness (e.g., Piazza, Fisher, Hagopian, Bowman, & Toole, 1996). Researchers might also consider replacing tangible prizes with accumulated access to leisure activities (e.g., iPad, video games) (DeLeon et al., 2014). Conceivably, participants could select the item or activity they would prefer to work for prior to the start of each session. This extension might be more practical with older children who would have a better understanding that number of tokens translate into time earned towards access to the selected leisure activity.

Second, due to time constraints (i.e., end of the academic year), we were unable to complete the second noncontingent condution and reinstate another contingent-token condition for one participant (Hubert) and were unable to carry out lengthier contingent phases for all three participants who showed differentiation. In general, without an extended analysis, the degree to which MVPA will persist is unknown. To address this limitation, researchers should consider incorporating extended sessions to assess for stability in responding and evaluate ways to thin the schedule of reinforcement while maintaining the response and increasing the session length.

Third, although a reversal effect was observed for three children (Philip, Hubert, Leela) during baseline probe and noncontingent-token conditions, total percentage of intervals with MVPA was still a somewhat low. During contingent-token sessions, Philip, Hubert, and Leela engaged in MVPA an overall average of 38.5%, 45.3%, and 43.3% of intervals, respectively. This translates to approximately 2 min (i.e., 1 min 55 s for Philip, 2 min 15 s for Hubert, 2 min 9 s for Leela) of overall MVPA over the course of a 5-min session. Physical activity patterns in preschool-aged children are typically intermittent, transient, and consist of alternating between brief bouts of MVPA and brief periods of rest (CDC, 2008; Ruiz, et al., 2013). Although these results do not approach the 60 min of MVPA in which children should engage each day, typical activity patterns should be taken into consideration when identifying ways to increase preschool children's overall MVPA throughout the day.

Another future research direction could be to incorporate a token reinforcement condition into an FA of MVPA, particularly for children who do not show differentiation in other reinforcement conditions (e.g., Zerger et al., 2016). A tangible condition in the form of a token economy might be a valuable condition to assess if results are initially undifferentiated, similar to the protocol for the inclusion of a tangible condition in a traditional FA (Thompson & Iwata, 2001). Ultimately, results from the assessment could be used to inform interventions and make recommendations with the aim to increase physical activity in young children. Further, it would also be interesting to parse out the effects of verbal descriptive attention ("You got a token!") with a non-verbal stimulus (e.g., a whistle or novel tone) to signify token delivery. Although this token system might be used initially to increase children's physical activity, the ultimate goal would be to fade it out over time as children contact natural contingencies of reinforcement associated with increased physical activity.

Despite the limitations, the present study demonstrated that the delivery of tokens contingent on MVPA can increase and maintain MVPA exhibited by preschool-aged children, resulting in more MVPA than in baseline and conditions in which tokens are awarded without respect to MVPA. These results exemplified yet another demonstration of the utility of a token economy procedure (Kazdin, 1982; Kazdin & Bootzin, 1972; see also Hackenberg, 2009), extended this research by applying token reinforcement procedures to MVPA, and more generally, adds to the literature on the robust effects of positive reinforcement. Additionally, it might be useful to evaluate token reinforcement prior to intervention (e.g., Larson et al., 2013; Larson et al., 2014) if MVPA appears insensitive to social consequences such as adult attention or interaction (e.g., Zerger et al., 2016). In turn, results can inform function-based interventions with the goal in increasing and maintaining higher levels of MVPA, and presumably increased likelihood of healthy development.

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APPENDIX A: TABLES

Table 1.

The Observational System for Recording Activity Level, Preschool Version (OSRAC-P)

Level	Activity	Operational Definition
1	Stationary or motionless	Stationary or motionless with no major limb movements or major joint movement (e.g., sleeping, standing, riding passively in a wagon)
2	Stationary with limb or trunk movements	Stationary with easy movements of limb(s) or trunk without translocation (e.g., standing up, holding a moderately heavy object, hanging off of bars)
3	Slow, easy movements	Translocation at a slow and easy pace (e.g., walking with translocation of both feet, slow and easy cycling, swinging without assistance and without leg kicks)
4	Moderate movements	Translocation at a moderate pace (e.g., walking uphill, two repetitions of skipping or jumping, climbing on monkey bars, hanging from bar with legs swinging)
5	Fast movements	Translocation at a fast or very fast pace (e.g., running)

Note. Adapted from Brown et al. (2006)

Table 2

Average Bouts of Moderate-to-Vigorous Physical Activity (MVPA)

Phase	Amy	Philip	Hubert	Leela
Contingent-token (1)	5.0 s	5.8 s	6.8 s	5.2 s
Noncontingent-token (1)	3.3 s	4.6 s	5.3 s	3.4 s
Contingent-token (2)	4.0 s	6.1 s	6.3 s	5.2 s
Noncontingent-token (2)	3.4 s		4.1 s	
Contingent-token (3)	4.7 s			

For all participants, average bouts or consecutive seconds of moderate-to-vigorous physical activity (MVPA) were calculated across contingent-token and noncontingent-token conditions. Two participants experienced the 2nd reversal to noncontingent-token (i.e., Amy, Hubert) and one experienced the 3rd reversal back to contingent-token (i.e., Amy).

APPENDIX B: FIGURES

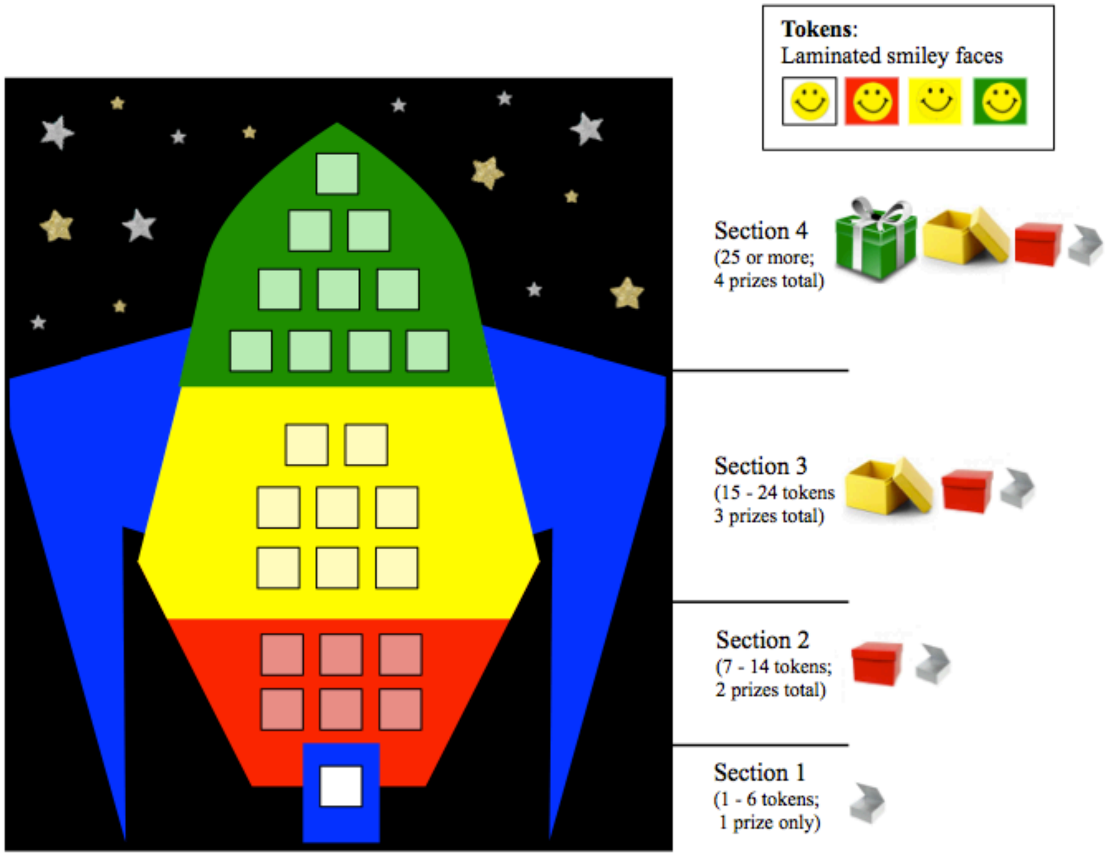

Figure 1. The token board depicted a rocket ship and was visible to participants throughout all contingent- and noncontingent-token sessions.

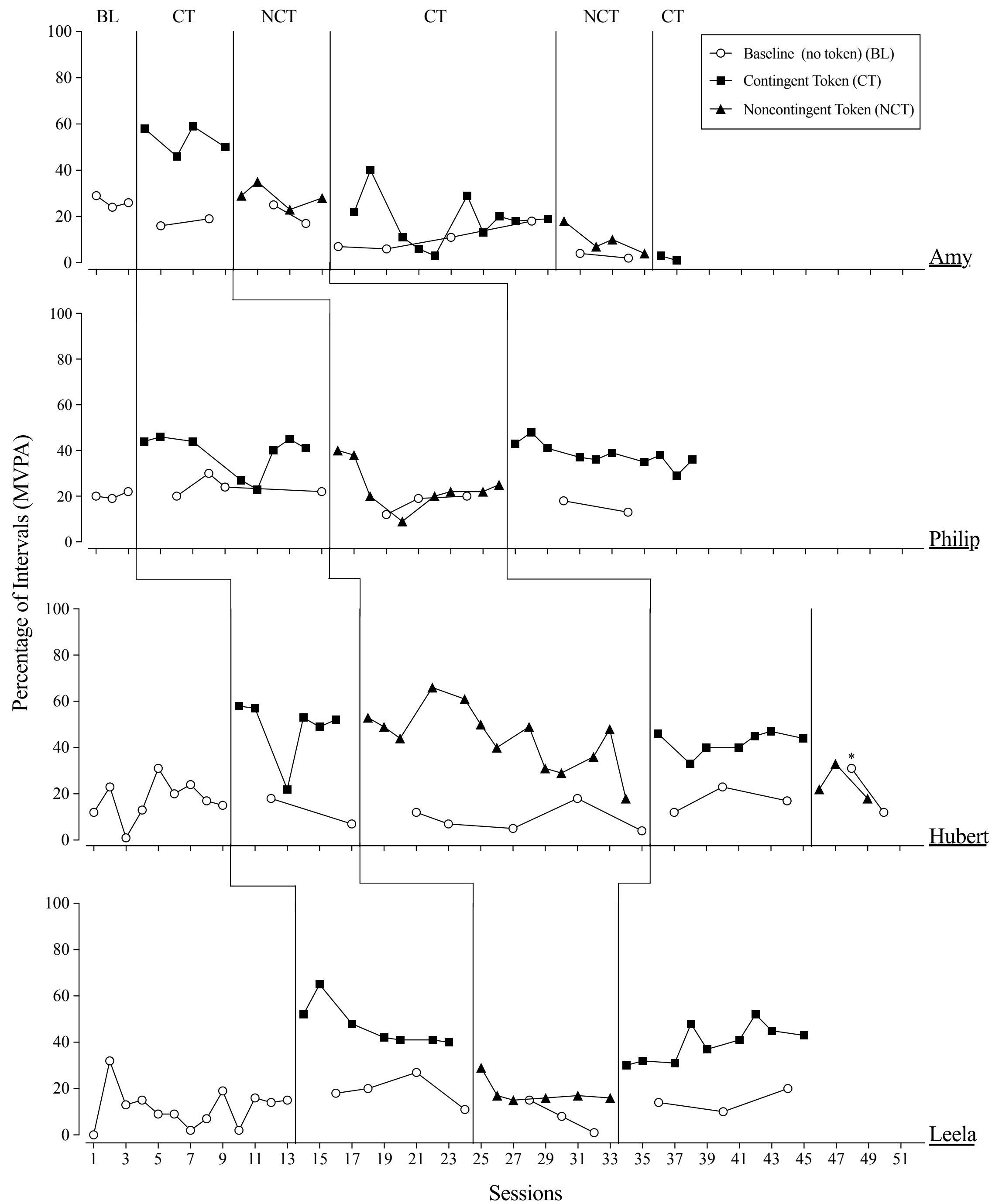

Figure 2. Percentage of intervals with moderate-to-vigorous physical activity (MVPA) observed across baseline (no token), baseline (no token) probes, contingent-token, and noncontingent-token conditions for Amy, Philip, Hubert, and Leela. The asterisk denotes a shortened session duration.

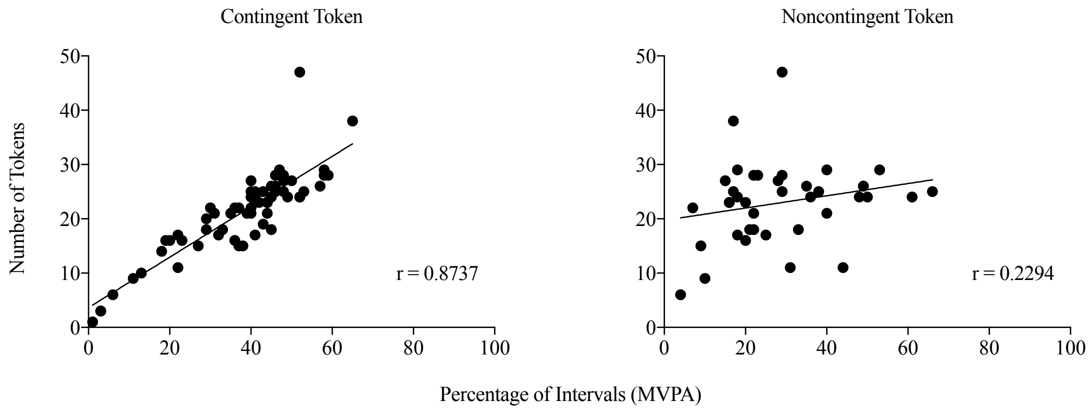

Figure 3. Pearson product-moment correlations coefficients were calculated for each experimental condition (i.e., contingent-token and noncontingent-token) across all participants.

APPENDIX C: THE EFFECT OF TOKEN REINFORCEMENT ON MODERATE-TO-VIGOROUS PHYSICAL ACTIVITY EXHIBITED BY YOUNG CHILDREN: FULL REVIEW

Major health and government organizations recommend children engage in at least 60 minutes of moderate-to-vigorous physical activity (MVPA) every day (American Heart Association [AHA], 2013; Centers for Disease Control and Prevention [CDC], 2015; World Health Organization [WHO], 2010) and identify this as the minimum level of physical activity required to achieve health benefits (CDC, 2010). Daily physical activity of moderate and vigorous intensities helps increase high-density lipoprotein (HDL, i.e., the "good" cholesterol) and reduce the risk of developing high blood pressure, obesity, and chronic diseases (U.S. Department of Health and Human Services [HHS], 2008). For young children, daily physical activity is critical for healthy development (AHA, 2014; CDC, n.d.; WHO, n.d.). Regular physical activity develops, strengthens, and stretches musculoskeletal tissues (i.e., bones, muscles, joints), develops a healthy cardiovascular system (i.e., strong lungs and heart for increased energy and endurance) and aids in the acquisition of fundamental coordination and movement control, (i.e., balance and reflexes; AHA, 2014; CDC, n.d.; WHO, n.d.). Despite the aforementioned health benefits, most children in the United States fail to meet these well-established guidelines (CDC, 2010). The price of physical inactivity includes an extensive range of long-term health consequences and monetary costs (AHA, 2013; HHS, 2008).

Physical inactivity is habitual for many and results in serious negative consequences for children (WHO, 2010). One result of physical inactivity is childhood overweight and obesity. For example, among children and adolescents aged 2-19 years, the prevalence of obesity is 17% (Ogden, Carroll, Kit, & Flegal, 2014). The fundamental cause of overweight and obesity is sustained energy intake which exceeds energy expenditure (Levi, Segal, St. Laurent, & Kohn, 2011). Physical activity is a key determinant of energy expenditure, energy balance, and weight control. However, childhood overweight and obesity is only one of many adverse health concerns related to physical inactivity. Childhood obesity and a sedentary lifestyle also increase the risk of future adverse health conditions such as noncommunicable diseases (NCD; Lee et al., 2012; WHO, 2010). NCDs are chronic diseases that are not passed from person to person, are long in duration, slow in progression, and largely preventable (WHO, n.d.). The major types of NCDs are cardiovascular diseases (e.g., heart attack, stroke), cancer (e.g., colon), respiratory diseases, and diabetes and their related risk factors include raised blood pressure, raised blood sugar, and being overweight and obese.

In addition to the personal health risks associated with a sedentary lifestyle in children, a significant financial strain is put on the government in the form of medical expenses (e.g., diagnostic and treatment services) and human capital costs (i.e., effects of overweight and obesity on educational attainment) (CDC, 2012; Hammond & Levine, 2010). The direct costs of childhood obesity include annual prescription drug, emergency room, and outpatient costs of $14.1 billion, plus inpatient costs of $237.6 million annually (Cawley, 2010). An even larger cost is incurred when obese children become obese adults. Moreover, days missed from school are significantly higher for obese children than their normal-weight counterparts (Geier, Foster, & Womble, 2007).

There is an epidemic of physical inactivity. Obesity and related NCDs are largely preventable and research focusing on increasing physical activity in young children is needed (WHO, n.d.). The preschool years are likely a crucial time to study the determinants of childhood inactivity because habits which can lead to childhood overweight and obesity develop early on in children's lives. Currently there is a lack of suitable assessments and interventions related to increasing and maintaining physical activity among young children. Prevention and interventions designed to evaluate environmental variables and behaviors related to physical activity are key to our understanding of physical activity among children.

Physical Activity Measurement

Physical activity is generally defined as “any bodily movement produced by skeletal muscles that requires energy expenditure” (Caspersen, Powell, & Christenson, 1985; WHO, n.d.). Accurate measures of physical activity are necessary to assess the effectiveness of interventions aimed at increasing physical activity (Sirard & Pate, 2001); one challenge is selecting a measurement strategy known to produce reliable and valid data. A wide variety of methods are used to measure physical activity, each with their advantages and limitations. These include subjective measures such as self- or proxy-reports, indirect measures (i.e., mechanical devices) such as heart rate (HR) monitors, pedometers, and accelerometers, and direct measures such as direct observation.

Self- and Proxy-Report

Subjective measures, such as self- or proxy-reports, participant interviews, and diaries are used most frequently in the assessment of physical activity due to low cost, convenience of administration, and low investigator and respondent burden (Prince et al., 2008; Sallis & Owen, 1999; Sirard & Pate, 2001). Self-report questionnaires can provide preliminary information on respondents’ activity patterns (Prince et al., 2008). Typically, respondents are asked to recall their activities over a particular time frame and these questionnaires can be administered via personal interview or telephone, or self-administered through mail or in person (Sallis & Owen, 1999). The Seven-Day Physical

Activity Recall Questionnaire (7-day PAR-Q) is a commonly used subjective measure in which participants are asked to identify activities they engaged in during the previous 7 days, and report duration spent on each activity (Sallis, Haskell, & Wood, 1985). Activities are classified by intensity (i.e., moderate, hard, and very hard) and metabolic equivalent of task (MET) values (i.e., physiological measure expressing the energy cost of physical activities) are assigned to each category (i.e., 4, 6, 10 METS respectively); for example, sleeping would have a MET value of 1 (Sallis et al., 1985). Because all survey methods rely on respondents' self-reports or responses to questions about their behavior, these survey methods are, by nature, subjective (Sirard & Pate, 2001).

Although self-report methods are the most common assessment tool for evaluating physical activity, they lack objectivity and often produce both unreliable and inaccurate data (Sirard & Pate, 2001). Studies comparing self-report data with other measures (e.g., mechanical measures, direct observation) have found both adults' and children's answers differ greatly when compared to actual behavior (Baranowski et al., 1984; Hands & Larkin, 2006; Klesges et al., 1990; Prince, et al. 2008; Poling, Methot, & LeSage, 1995; Sallis et al., 1993). Children lack the ability to recall details about their activity patterns (e.g., duration, intensity of activities performed), are largely unable to report accurate information, and tend to overestimate their engagement in physical activity (Vanhees et al., 2005; Welk, Corbin, & Dale, 2000; Sallis, 1991). Parents or teachers are often asked to provide "proxy" reports on children's behavior, and this also reduces reliability and validity of the data (Telford, Salmon, Jolley, & Crawford, 2004).

Mechanical Devices

HR is an objective measure that serves as an indirect estimate of physical activity by indicating the relative stress placed upon the cardio-respiratory system during movement (Vanhees et al., 2005). It is limited as a proxy for actual physical activity because it relies on the assumption that a linear relationship exists between HR and oxygen uptake (VO_2) (Oliver, Schofield, & Kolt, 2007). For moderate-intensity activities, this linear relationship tends to be accurate, but at high- and low-intensity activities more errors occur. In addition, the proportion of active muscle mass and type of activity (i.e., whether it is continuous or intermittent) can also affect the HR – VO_2 relationship (Rowlands, Eston, & Ingledew, 1997). Further, physical activity is not the only cause of increased HR. HR is sensitive to a number of factors, independent of any change in oxygen uptake, such as caffeine, emotional stress, smoking, and body position (Oliver et al., 2007; Vanhees et al., 2005). Because children's HR is consistently low throughout the day (Rowlands et al., 1997), HR is a less appropriate measure of their physical activity.

Motion sensors, such as pedometers and accelerometers register body motions that reliably and objectively quantify physical activity. Both are small, portable, mechanical devices typically worn at the hip. Pedometers register movements in a vertical direction, thereby only providing information on step count totals. Consequently, only walking- or running-related activities can be registered accurately. Pedometers are limited by their inability to provide information about the pattern or intensity of movement (Sirard & Pate, 2001). On the other hand, accelerometers sense user movement and track the force of motion, thus providing more accurate estimates of physical activity intensity and duration. Key advantages of motion sensors include an ability to quantify activity over extended periods of time, data free of researcher bias, and lower data collection burden for the researcher and participants. However, similar to pedometers, accelerometers are limited in that they are unable to provide information about the type of physical activity, environmental contexts, or social variables in which physical activity occurs, and they also fail to record certain types of complex movements (e.g., cycling, upper body movements, and swimming; Oliver et al., 2007; Vanhees et al., 2005).

Direct Observation

Direct observation systems are considered the gold standard measure of physical activity (Oliver et al., 2007; Sirard & Pate, 2001; Vanhees et al., 2005). These systems address limitations of other measurement methods in that both the type of activity (i.e., record activity level) and moment-to-moment activity are quantified in a variety of environmental settings or contexts (Sallis & Owen, 1999). Under this method, a child's physical activity is directly observed and recorded by an observer under the stimulus control of a written behavior code or observation system (Baer, Wolf, & Risley, 1987). Direct observation is often used to study physical activity in children because other assessments methods (e.g., questionnaires, heart rate monitors) are often not appropriate or valid for this age group (Vanhees et al., 2005).

Most direct observation systems were developed to record behavior as it occurs in real time; the data generated by these recordings yield information about frequency and duration of participants' physical activity (e.g., The FATS, Klesges, 1984; SOFIT, McKenzie, Sallis, & Nader, 1991; BEACHES, McKenzie et al., 1991; CARS, Puhl, Greaves, Hoyt, & Baranowski, 1990). For example, the Observational System for Recording Physical Activity in Children-Preschool Version (OSRAC-P; Brown et al., 2006) is a direct observation system created specifically to collect information on preschool-aged children's physical activity within environmental contexts and social interactions. The OSRAC-P uses a five-point activity rating scale to code varying intensity levels (i.e., Level 1 denoting stationary or motionless to Level 5 denoting fast movements) and environmental events (e.g., physical activity type, locations, indoor activity codes, outdoor activity codes, activity initiator codes, group composition codes, and adults and peer prompts for physical activity codes).

Direct observation systems are typically used with an interval recording system where behavior is either recorded in continuous intervals (Hustyi, Normand, Larson & Morley; 2012; Larson, Normand, Morley & Miller, 2013; Larson, Normand, Morley, & Miller; 2014; Morley, Normand, & Larson, 2012, May) or discontinuous intervals (Brown, et al., 2009; Klesges, 1984; McKenzie et al., 1991; Puhl et al., 1990). For example, Brown and colleagues (2009) evaluated the OSCRAC-P using a 5-s observe, 25-s record discontinuous partial-interval recording method in which the highest level of physical activity and related environmental events during the 5-s observe was recorded. However, time sampling and discontinuous interval recording methods used to assess intermittent and continuous rate of responding often result in measurement error (Repp, Roberts, Slack, Repp, & Berkler, 1976). Partial-interval recording methods tend to underestimate occurrence (rate) of behavior and overestimate the total duration of behavior due to a lenient criterion (Cooper, Heron, Heward, 2007; Repp et al., 1976). Continuous measures of physical activity (i.e., second-by-second accounts) provide a more accurate and comprehensive account of activity. Direct observation systems are typically used for descriptive purposes, that is, they are used in situations that do not involve experimental manipulations.

Descriptive assessments. Descriptive assessments involve observation of behavior in naturally occurring conditions and provide topographical information about the manner in which behavior occurs, often by making use of one or more of the coding systems described above. Correlations (i.e., obtained via direct observation) are identified among raw data that can generate useful questions for further experimental inquiry (Bijou, Peterson, & Ault, 1968). Brown and colleagues (2009) used a descriptive assessment method and identified environmental contexts as predictors of physical activity in preschool-aged children. They analyzed intervals in which participants engaged in MVPA from a large sample of naturalistic observations. MVPA was measured using the OSRAC-P observation system (Brown et al., 2006) and results showed elevated levels of MVPA in the open space context, followed by the fixed equipment context, then the outdoor toys context; however, because these data are correlational, functional relationships between environmental contexts and MVPA could not be identified.

Morley et al. (2012, May) directly compared the results of descriptive assessments (i.e., 30-min session length, 8 sessions, 4 hours total) and functional analyses (i.e., 5-min session length, 18 sessions, 1.5 hours total) of MVPA in preschool-aged children. They found a high correspondence between the descriptive assessment and functional analyses with regards to identifying the context which evoked the highest levels of MVPA. However, descriptive assessment methods did not identify other activity contexts also related to higher levels of MVPA, which were identified by the functional analyses. Additionally, descriptive assessments required significantly longer sessions and substantially more time to code data. Descriptive assessments can provide a broader account of the variables associated with physical activity; however, they cannot be used to identify antecedent conditions that reliably evoke a given behavior, nor can they be used to identify consequences which maintain, increase, or decrease a given behavior. Experimental assessments, which require shorter observation times and less time to code, can be used to identify variables functionally related to physical activity.

Functional Analysis of Behavior

Structural Analysis

The AB functional analysis (FA) model, or structural analysis, manipulates only antecedent events (Hanley et al., 2003); no programmed consequences are arranged for the target behavior. Previous studies have focused on a single response-reinforcer relation and have demonstrated functional relationships between a specific event and a wide variety of problem behaviors (e.g., aggression, disruption, escape from instruction, self-injurious behavior) among the developmentally delayed population (Lovaas, Fretiag, Gold, & Kassorla, 1965; Pinkston, Reese, LeBlanc, & Baer, 1973; Sailor, Guess, Rutherford, & Baer; Thomas, Becker, & Armstrong, 1968; as cited by Hanley et al., 2003). These early studies established the basic methodological features of the current FA method (i.e., the direct observation and measurement of problem behavior under test and control conditions in which environmental variables are manipulated; Hanley et al., 2003). Carr and Durand (1985) developed the AB FA method to identify conditions under which problem behavior (i.e., aggression, tantrums, self-injury) exhibited by four children with developmental disabilities was most likely to occur. They manipulated antecedent events and demonstrated a functional relationship between specific antecedent events and problem behavior. They also showed that results from their assessment strategy could be used to develop a successful intervention to reduce children's problem behavior.

With a focus on increasing desirable behavior, Hustyi and colleagues (2012) used an antecedent FA methodology to identify outdoor activity contexts that evoked higher levels of MVPA in four typically developing preschool-aged children. They extended Brown et al.'s (2009) methodology by systematically exposing participants to those activity contexts (i.e., open space, fixed equipment, outdoor toys), and added control and 30-min naturalistic observation conditions. Sessions were 5 min in length and were arranged in a multi-element design. Participants were instructed to play in a specific area of the daycare playground and were limited to that area throughout the session. The open space (OS) context was a large grassy area free of any activity materials (i.e., toys, balls, fixed equipment). The fixed equipment (FE) context was a jungle gym play structure. In the outdoor toys (OT) context, objects used in gross motor movement were made available (e.g., Frisbees, balls, hula hoops). Lastly, the control condition consisted of an area on the playground with a table and activities (e.g., coloring books, crayons), which was not expected to evoke high levels of physical activity. Percentage of intervals with MVPA was coded using the OSRAC-P (Brown et al., 2006). Results showed that although the participants were generally sedentary, differentiated levels of MVPA were observed across environmental contexts. Inconsistent with Brown et al.'s (2009) findings that OS was correlated with the highest levels of MVPA, Hustyi et al. (2012) results showed that FE evoked the highest levels of MVPA followed by OS and OT. However, consequences were not delivered following behavior as they might be in the natural environment; therefore, although variables that occasioned behavior were identified, variables which maintained behavior were not. To identify variables that maintain or increase physical activity, consequent variables must be assessed experimentally.

ABC Functional Analysis

The ABC FA manipulates both antecedent and consequent events to identify the function of behavior (Hanley et al., 2003). Iwata, Dorsey, Slifer, Bauman, & Richman (1982/1994) published the first comprehensive assessment study in which they experimentally demonstrated that specific environmental variables were related to and reinforcing self-injurious behavior (SIB) in children with developmental delays. Iwata and colleagues (1982/1994) developed a methodology that systematically manipulated both antecedent and consequent events across three experimental test conditions: social disapproval (i.e., contingent attention for SIB), academic demand (i.e., removal of task demand contingent on SIB), alone (i.e., placement in a room alone to assess SIB absent of social contingencies), and a control condition (i.e., unstructured play condition). All test and control conditions were 15 min in duration, were rapidly alternated, and repeated several times in a multielement experimental design. Using this method, Iwata and colleagues (1982/1994) demonstrated it was possible to empirically identify functional relationships between SIB and specific environmental arrangements and that these functions differed across individuals. This finding led to the implementation of more effective, function-based interventions.

Since Iwata et al. (1982/1994), numerous studies have replicated and extended the

FA methodology in different ways. For example, Iwata, Duncan, Zarcone, Lerman, and Shore (1994) incorporated a sequential, test-control design for conducting functional analyses of SIB. The application of FAs has also extended to naturalistic settings such as in the client's home (Wacker, Berg, Derby, Asmus, & Healey, 1998) and in the participant's classrooms (Wright-Gallo, Higbee, Reagon, & Davey, 2006). FA conditions are typically 5 to 10 min in duration and when assessment time is limited, this might not be feasible. Northup et al. (1991) used an analogue assessment which involved administrating only one of each test condition. Further, trial-based FAs in which 1-min test and control conditions are alternated in a pairwise fashion have also been assessed, in classroom settings (Bloom, Iwata, Fritz, Roscoe, and Carreau, 2011; Sigafoos & Saggers, 1995) and in a vocational training context (Wallace & Knights, 2003).

The Iwata et al. (1982/1994) FA methodology has been used to identify the function of a wide range of problem behaviors in a variety of populations, particularly among individuals diagnosed with developmental disabilities (Hanley et al., 2003). Moreover, the FA has been used to identify the function of appropriate behaviors with the ultimate goal of increasing these behaviors (e.g., Cooper, Wacker, Sasso, Reimers, & Don, 1990; Cooper et al., 1992; Hanley et al., 2003; Larson et al., 2013; Larson et al., 2014; Normand, Machado, Hustyi, & Morley, 2013; Schieltz et al., 2010).

Functional Analysis of Physical Activity

Recently, researchers have assessed physical activity exhibited by preschool-aged children using the ABC FA methodology (Larson et al., 2013; Larson et al., 2014; Zerger, Normand, Boga, & Patel, 2016). Larson et al. (2013) assessed the function of social and nonsocial consequences on activity levels of two preschool-aged children.

This study extended the assessment methodology reported by Hustyi et al. (2012) by providing information about whether delivery of consequences related to specific antecedent conditions maintained higher activity levels. Two participants were evaluated under four experimental conditions (i.e., attention, interactive play, escape, alone) and a control condition. During the attention condition, contingent on MVPA, the experimenter delivered attention in the form of brief specific praise. During the interactive play condition, contingent on MVPA, the experimenter physically engaged in the activity with the participant and delivered verbal attention, simultaneously. During the escape condition, participants were instructed to complete preacademic tasks; contingent on MVPA, the experimenter would have turned away from the participant for 30 s, however, both participants complied with all preacademic tasks. During the alone condition, the primary experimenter was out of sight and the secondary experimenter video supervised the participants and video recorded the session; there were no programmed consequences delivered contingent on MVPA in this condition. During the control condition, participants engaged in an activity unlikely to evoke MVPA (i.e., coloring activity); no programmed consequences were delivered contingent on MVPA and verbal attention was delivered according to a fixed-time (FT) 30 s schedule. Results showed that for both participants, contingent interaction resulted in higher levels of MVPA. However, because attention was delivered in both the attention and interactive play conditions, it was unclear whether engaging in the activity with the participants was necessary to produce high levels of MVPA.

Larson et al. (2014) replicated and extended Larson et al. (2013). Their extension addressed the interactive play confound by also delivering attention on a FT 30-s schedule, independent of MVPA, and created a more ecologically valid escape condition (i.e., instead of instructing participants to complete preacademic tasks, they were instructed to clean up playground toys and materials). They also included a brief treatment evaluation; to demonstrate MVPA would remain at high levels following the FA, they included a return to the naturalistic baseline followed by a reversal to the FA condition which evoked the highest levels of MVPA. Results showed that for all four participants, higher levels of MVPA were consistently observed in the interactive play and attention conditions, whereas the alone, escape, and control conditions produced lower or no levels of MVPA. These results suggest positive reinforcement in the form of adult interaction or attention can play an important role in increasing activity levels exhibited by preschool-aged children.

Zerger et al. (2016) replicated and extended Larson et al.'s (2014) methodology by evaluating the development of an intervention based on the results of an FA. In Phase 1, they conducted an FA of MVPA. In Phase 2, they conducted an intervention analysis; contingent reinforcement (CR) and noncontingent reinforcement (NCR) were evaluated to determine if MVPA would increase regardless of the schedule for delivering attention or interaction. That is, they compared the condition that evoked the highest level of MVPA in the FA (i.e., attention, interactive play) to noncontingent interactions on an FT schedule of reinforcement. In the FA, differentiation in the attention condition, the interactive play condition, or both was observed for five of seven participants. In the intervention analysis, when CR and NCR conditions were compared, three of these participants showed elevated levels of MVPA only in the CR conditions, one participant showed no clear reversals, and one participant was dropped from the study due to unclear data patterns and time constraints. FA results for the other two of seven participants were undifferentiated across all experimental conditions. Although, these results show some participants' MVPA was sensitive to contingent social consequences, of the five participants who showed differentiation in the FA, MVPA exhibited by two participants was undifferentiated across CR and NCR phases. These findings suggest a need for additional research on improving the FA methodology for increasing MVPA by assessing a supplementary reinforcement contingency.

The clinical utility of the FA methodology has been shown to accurately identify the function of target behaviors across clinical settings (e.g., hospitals, schools, homes, outpatient clinical settings) for both aberrant (e.g., aggression, pica, stereotypy, tantrums; Vollmer, Marcus, Ringdahl, & Roane, 1995) and appropriate behaviors (e.g., on-task behaviors, manding, infant sign language, MVPA; Cooper et al., 1990; Cooper et al., 1992; Hustyi et al., 2012; Larson et al., 2013; Larson et al., 2014; Normand et al., 2013; Schieltz et al., 2010; Zerger et al., 2016). To date, MVPA has not been evaluated using a tangible FA condition. In general, few published studies have examined the functional relationship between tangibles and appropriate behaviors using the FA methodology. Because tangibles are often used by clinicians, teachers, and other professionals to directly, or indirectly in the form of a token economy, reduce children's problem behavior and increase appropriate behavior, it is important to examine whether preschool-aged children's MVPA is functionally related to positive reinforcement in the form of access to tangibles.

Functional Analysis of Tangible Reinforcement

The purpose of an FA tangible condition is to assess whether a target behavior is maintained via contingent access to a preferred item or activity (e.g., toys, games, privileges). Mace and West (1986) were the first to include an experimental condition that assessed the effect of tangible reinforcement on problem behavior (i.e., reluctant speech); however, Day and colleagues (1988) are cited as the earliest study to demonstrate behavioral maintenance by access to tangible items (Hanley et al., 2003). That is, they demonstrated the functional properties of access to a tangible by providing three individuals with intellectual and developmental disabilities (IDD) access to preferred items contingent on SIB; for two participants, differentiation was observed in the tangible condition compared to the other FA conditions (i.e., demand and alone).

In a typical tangible procedure, contingent on the occurrence of problem behavior, the clinician or experimenter immediately presents a tangible item and allows the participant to manipulate the object for approximately 30 s; during this condition, there are no other programmed consequences, and all other responses are ignored. To ensure the tangible condition session length equates to that of the other FA conditions (i.e., 5 min), each 30-s period during which the tangible is made accessible is added to the session duration.

Because of the potential risks associated with a tangible condition, it is implemented only when pre-experimental information (i.e., parent or teacher anecdotal reports, descriptive assessments) suggests problem behavior occurs as a function of access to a tangible and should include only those tangible items delivered as a consequence for problem behavior in the past. A key risk of including a tangible condition in an FA is that the behavior might contact new sources of reinforcement previously unrelated to the behavior and might acquire a new tangible function (Vollmer et al., 1995). For example, Shirley and colleagues (1999) found that tangible stimuli identified through preference assessments for use in an FA did not maintain SIB, but acquired such control when presented contingent on SIB. Behavior that is not maintained by tangible reinforcement might still be sensitive to it. That is, if, in the natural environment, a highly preferred item is not delivered as a consequence to the target behavior and during assessment, access to the highly preferred item is made contingent on the occurrence of the target behavior, the behavior will likely increase (Galiastatos & Graff, 2003; Shirley et al., 1999). In some cases, exposure to highly preferred stimuli during assessment in the tangible condition can produce erroneous data where a tangible function is incorrectly identified (i.e., false positives), even when a tangible function might not have existed prior to the FA (Galiatsatos & Graff, 2003; Rooker et al., 2011; Shirley et al., 1999). Rooker and colleagues (2011) found behavior maintained by automatic reinforcement was also highly sensitive to tangible reinforcers. So, if a behavior is already maintained by social reinforcement, it is even more likely to come under the control of preferred tangible reinforcers. When including a tangible condition with the intent of increasing appropriate behavior (e.g., MVPA), the potential limitations might not be as severe or problematic as they are for problem behavior. With problem behavior, creating a tangible function can be harmful and counterproductive. However, with appropriate behavior, clinicians often make use of new tangible functions; in fact, this is often the purpose of token economy systems.

When assessing a tangible condition in an FA of MVPA, an accumulated arrangement might be particularly useful because it can be undesirable to have participants terminate MVPA for 15 s or 30 s while they access the tangible, as this interrupts sustained bouts of MVPA. DeLeon and colleagues (2014) compared distributed reinforcement (immediate access to tangibles) and accumulated reinforcement with four adolescents and young adults diagnosed with IDD. In the distributed reinforcement condition, contingent on meeting a small response requirement, each participant was given immediate 30-s access to a tangible (i.e., activity/leisure-based reinforcer, e.g., books, activities, puzzles). In the accumulated reinforcement condition, participants earned tokens contingent on the same response requirement and were allowed to exchange the tokens at the end of a session; the accumulated reinforcement condition resulted in participants having a delayed but longer, continuous access to the tangible. Experiment 1 evaluated the effect of both reinforcement procedures on participants' rate of completing 10 tasks (i.e., folding towels, sorting office supplies, matching rows of colored blocks). Results showed participants had higher rates of responding in the accumulated reinforcement condition. Additionally, the mean amount of reinforcement earned (i.e., access to activity-based reinforcers) during the accumulated arrangement was greater than that earned in the distributed arrangement (3.1 min and 2.4 min, respectively). In Experiment 2, DeLeon and colleagues (2014) compared the total time it took participants to complete 10 academic tasks, each presented as a discrete trial, for each reinforcement arrangement. They also tested participants' preference for the reinforcement procedures when the reinforcer was an activity compared to an edible. Accumulated access to both activities and edibles produced faster task completion compared to distributed reinforcement and accumulated access to activities produced faster task completion rates compared to accumulated access to edibles. These findings suggest accumulated reinforcement might provide a more efficient use of work periods when accrued access to a tangible is delivered at the conclusion of a work period.

Token Economy

The token economy system uses incentives (i.e., tokens exchangeable for other reinforcers) to shape and modify behavior, and has been used to successfully increase desirable behavior in children across a number of different settings (e.g., residential programs, inpatient facilities, educational settings). Basic laboratory research on token reinforcement began in the early 1930s. Tokens effectively established and maintained target behavior, albeit somewhat less effectively than unconditioned reinforcers (e.g., food, water; Hackenberg, 2009). In addition, generalized conditioned reinforcers (i.e., when tokens can be exchanged for an array of preferred items and activities) sustain performance for extended periods (Kazdin, 1977). Moreover, performance produced under a token economy approximates, in both patterning and rate, performance under similar schedules of food reinforcement (Hackenberg, 2009). The transition from basic laboratory research to applied research using token reinforcement began in the 1960's with use among psychiatric patients and children. The inception of the token economy is credited to Ayllon and Azrin who designed and put into effect the first program at Anna State Hospital in Illinois in 1961 among psychiatric patients (Kazdin, 1977).

One persisting criticism of programs that use token economies is the overjustification effect (Deci, 1971; Kohn, 1993; Lepper, Greene, & Nisbett, 1973). The overjustification hypothesis states that programs that provide extrinsic consequences for a given behavior will alter or replace the intrinsically motivating factors of that behavior (Lepper et al., 1973). This effect also assumes that these token systems will create situations in which individuals become dependent on extrinsic consequences and will only behave if tangible tokens or backup rewards are available (Kazdin, 1977; Doll et al., 2013). However, researchers have tested these hypotheses and have found the opposite (e.g., Fisher, 1979; McGinnis, Friman, & Carlyon, 1999; Peters & Vollmer, 2014); when reinforcement is made contingent on specific behavior across several sessions, planned withdrawal of token reinforcement can increase performance compared to baseline (Kazdin, 1977). The reasons for the discrepancies between these findings and studies that seem to uncover an overjustification effect, likely have to do with the targeted behaviors of interest. Studies addressing the issue of the deleterious effects of rewards, often study a response that is already at strength in the individual's repertoire. However, token economies are often used when the individual is not exhibiting the target behavior with the goal of initiating or developing behavior(s) and a plan for gradually fading the system in place so that natural consequences can control continued performance of the target behavior (i.e., maintenance; Kazdin & Bootzin, 1972; Kazdin, 1977). There is no reason to arrange a contrived reinforcement contingency for behavior that is already occurring. Moreover, critics have also argued that extrinsic reinforcement is a form of bribery or blackmail; however, they do not reinforce unethical or illegal behaviors, are small in size relative to the behavior being reinforced, and are provided contingent on the behavior (i.e., after the behavior occurs) rather than before the behavior occurs, as is often the case with bribery (Doll et al., 2013; Kazdin, 1977).

A variety of token economies have been developed (e.g., lottery system, level systems) to modify behavior when implemented correctly (Kazdin, 1977). However, token economies are not without limitations, in that clients might steal tokens, so tokens should be marked in some way to individualize them so that theft is unprofitable, there could be lack of participation in the token economy intervention, or nonresponsiveness with certain populations (i.e., some individuals are unaffected by token reinforcement contingencies; Kazdin, 1977; Kazdin, 1988; Kazdin & Bootzin, 1972). Although these limitations appear less likely to occur when interventionists are working one-on-one with typically developing preschool-aged children, token economies can evoke disruptive behavior in the form of anger, complaints, or refusal to use the token economy or exchange tokens (Kazdin & Bootzkin, 1972). However, these limitations can be mitigated if the client or patient has an important role in developing the contingencies of the token economy. For example, a work schedule that was created and set by a student was associated with higher rates of performance (i.e., task completion) compared to a schedule imposed only by the teacher (Lovitt & Curtiss, 1969).

Overall, token economies have been successfully implemented with many different populations in a variety of environments, some of which include psychiatric inpatients (e.g., Ayllon & Azrin, 1965; 1968a; Atthowe & Krasner, 1968; Henderson & Scoles, 1970; Li & Wang, 1994; Lippman & Motta, 1993), individuals diagnosed with developmental delays and autism (e.g., Ferster & DeMyer, 1961, 1962; Fiske et al., 2015; McDonald & Hemmes, 2003; Steeves, Martin, & Pear, 1970; Tarbox, Ghezzi, & Wilson, 2006; Zimmerman, Stuckey, Garlick, & Miller, 1969), adolescents in the juvenile justice system (e.g., Cohen, Filipczak, & Bis, 1968; Phillips, 1968; Phillips et al., 1971; Phillips et al., 1973; Tyler, 1967), and students in classrooms (e.g., Birnbrauer & Lawler, 1964; Birnbrauer, Wolf, Kidder, & Tague, 1965; Broden, Hall, Dunlap, & Clark, 1970). Token economies used in classrooms for children have focused on reducing disruptive behavior and increasing attentive behavior (e.g., Jones & Kazdin, 1975; Kuypers, Becker, & O'Leary, 1968; O'Leary & Becker, 1967; Walker & Buckley, 1968). Token economies have also been useful in increasing academic tasks or on-task behaviors (e.g., Barrish, Saunders, & Wolf, 1969; Birnbrauer et al., 1965; Bushell, Wrobel, Michaelis, 1968; Fiske et al., 2015; McLaughlin & Malaby, 1972, 1975; Wolf, Giles, & Hall, 1968). Some classroom token systems employ group contingencies, like the *Good Behavior Game* (GBG; e.g., Barrish et al., 1969; Donaldson, Vollmer, Krous, Downs, Berard, 2011; Donaldson, Wiskow, & Soto, 2015). Token economies also have been successfully used to modify different target behaviors among typically developing children outside of the classroom, for example medication adherence (Da Costa, Rapoff, Lemanek, & Goldstein, 1997), reducing TV time (Wolfe, Mendes, & Factor, 1984), and increasing compliance to hemodialysis (Carton & Schweitzer, 1996).

For a token economy to be effective, the individual's behavior must be sensitive to the contingencies put into place; put more colloquially, an effective token economy relies partially on an individual's ability to comprehend the system in place as well as the reinforcing value of the items for which the tokens are exchanged. With respect to preschool-aged children, the token economy should be developmentally appropriate. For example, tokens that take the form of points and translate to accumulated time towards access to a leisure-based activity might to be too complex, as the skills of addition, subtraction, and tracking time are not typically part of preschool children's repertoire.

The token economy should be simple and have clear, specific criteria. Before the token economy is implemented, young children should be provided with token training and demonstrate skill acquisition.

For example, Herman and Tramontana (1971) used a token economy to reduce disruptive behavior exhibited by individual preschool-aged children and groups of preschool-aged children. Tokens took the form of ping pong balls and token training was implemented prior to using the token system. Each child had a bin with their name labeled on it, and were told they could take home a toy when their bin was filled with ping pong balls. First, they were instructed to individually fill up their bins from a tub of 100 ping pong balls and thereafter received a 10-cent toy of their choice. Next, the children were informed the experimenters would deliver the ping pong balls. Children who met criterion (i.e., filled bin) were able to exchange the balls for a toy; those who did not meet criterion were told they could play the game the next day for another opportunity to win a toy. A combination of daily instructions (i.e., of the token system in place) and token reinforcement was effective in reducing disruptive behaviors among both individuals and groups. However, behavior change specific to the experimental room did not generalize to the classroom. That is, disruptive behaviors increased to near baseline levels in the classroom, highlighting the importance of implementing the token economy in the desired environment and programming for generalization.

Sran and Borrero (2010) assessed a token economy designed to increase accurate tracing of numbers and letters among four typically developing preschool aged children who were provided a choice between different back up reinforcers (i.e., tokens exchanged for a highly preferred edible or a token that could be exchanged for a variety of preferred edibles). Tokens took the form of poker chips and prior to the implementation of the token economy, each participant was given two to four tokens noncontingently (i.e., token delivery) and was asked to hand the experimenter one token at a time. Each token handed to the experimenter produced one bite of food (i.e., token exchange) and after all the tokens had been exchanged, the token economy was implemented. Participant's response rates were compared under three experimental conditions, each of which resulted in children receiving tokens exchangeable for one or more preferred edible items. Although, the main focus of this study assessed choice in relation to response rate, overall, all four participants had higher rates of responding in all three experimental conditions relative to their baseline responding. The token training methods used by both Herman and Tramontana (1971) and Sran and Borrero (2010) appeared effective, as neither explicitly mentioned limitation with regards to participants' understanding of the token economy system.

Wolfe, Boyd, and Wolfe (1983) used a token economy (i.e., sticker chart) to increase cooperative play (i.e., sharing) and reduce disruptive behavior in three preschool-aged children. They described their token training methods as follows: participants learned about the token system with a combination of verbal instructions from the teacher and receipt of tokens (i.e., happy face stickers) contingent on the specified behavior (i.e., sharing). Participants and their partners who engaged in sharing behaviors for a full minute received happy face stickers on their personal sticker charts from their teacher. During the 1-min session, the teacher also delivered general and specific praise (i.e., social reinforcement; e.g., "I like the way Jimmy is playing with Billy"). At the end of each session, those who did not earn a token were prompted to engage in sharing during the next opportunity and were reminded of the backup reinforcers they could earn (i.e., outside play). For all three participants, the mean percentage of time spent in cooperative play increased by at least 50% over baseline levels. Results of this study suggest stickers on a chart can serve as effective tokens for preschool-aged children.

In summary, researchers have incorporated multiple elements into token economy training procedures for young children: verbal instructions, reminders of the rules, and modeling contingent token delivery and token exchange (Herman & Tramontana, 1971; Sran & Borerro, 2010; Wolfe et al., 1983). However, the length of time and number of sessions young children require, prior to the start of formal data collection, varies somewhat by context and type of token economy. Token training in the form of verbal instructions and/or modeling appears to take minimal time and effort for typically developing young children (Cooper et al., 2007, and e.g., Sran & Borrero, 2010; Wolfe et al., 1983). Generally, for this population, initial token training can be achieved in one 30- to 60-min session consisting of three steps including an explanation of the token system, modeling the procedure for token delivery, and token exchange (Cooper et al., 2007). Children who do not contact reinforcement during sessions, can be told they have an opportunity to earn tokens next time and this appears to be effective for most children (Herman & Tramontana, 1971; Wolfe et al., 1983). Researchers also recommend tokens be salient, obvious, and visible to the preschool-aged children throughout the token economy intervention (Herman & Tramontana, 1971; Sran & Borerro, 2010; Wolfe et al., 1983). Finally, the target behavior of focus in the token economy should be acceptable to both children and their caregivers and the treatment should have a strong likelihood of being effective (Kazdin, 1980a; Wolf, 1978).

Token Economies and Physical Activity

Zerger et al. (2016) reported that two of the seven participants exhibited undifferentiated responding across all four FA conditions (i.e., control, alone, interactive play, attention) evaluated in the FA. Moreover, even among the five participants who exhibited more MVPA during the two types of social positive reinforcement conditions, two participants engaged in MVPA that was undifferentiated across both conditions during the intervention analysis. If a tangible condition, in the form of a token economy effectively increases physical activity, this could prove advantageous, especially for preschool-aged children who do not respond to social positive contingencies. In the current study, we propose to investigate the use of an accumulated token reinforcement system as a method of increasing physical activity among preschool-aged children, a target behavior typically valued by parents, caregivers, and their children. A tangible condition that makes use of accumulated reinforcement (DeLeon et al., 2014) has benefits over that of a typical FA tangible condition. Use of an accumulated reinforcement or token economy procedure would allow young children to play continuously; whereas, provision of tangibles immediately contingent on MVPA causes frequent interruptions, requires more time and effort on the part of participants to reorient back to the task following each reinforcer delivery, and results in less cumulative and continuous engagement in MVPA (DeLeon et al., 2014). Moreover, it would allow for the assessment of the function of tangibles on preschool-aged children's MVPA without interrupting physical activity.

Assessing the effects of an accumulated token reinforcement is justified for several reasons. It is possible a child might become habituated to adult attention and interaction, particularly if the same adult is delivering one or both; tokens allow for the delivery of a variety of tangible reinforcers (e.g., toys, activities, privileges). Additionally, tangibles might be useful for adults who are unable to engage in MVPA with a child (i.e., adults with physical limitations). It is also possible attention and interaction with certain adults do not serve as powerful reinforcers for some children, and access to tangibles might be more effective in increasing MVPA in those children. Further, access to a tangible helps maintain consistency when multiple adults are working with a child, especially if a child prefers one parent, guardian, or teacher over another. Lastly, the quality of praise might also vary among adults (i.e., parent/guardian differences); whereas, the quality of a tangible is consistent. Further investigation is needed to first assess the function of token reinforcement on MVPA exhibited by preschool-aged children.

Summary and Purpose of the Proposed Study

In the United States, few children meet the established guidelines stating that young children should engage in at least 60 min of MVPA every day (AHA, 2013; CDC, 2011; WHO, 2010). Given that over 3 million people die each year from complications resulting from inadequate levels of physical activity, and daily physical activity in young children is critical for healthy development (AHA, 2014; CDC, n.d.; USDA; n.d.; WHO, n.d), increasing the time children spend in MVPA is an important goal for the health of children and our society. The FA methodology has provided important information regarding outdoor activity contexts and reinforcement contingencies functionally related to increased MVPA exhibited by young children (Hustyi et al., 2012; Larson et al., 2013; Larson et al., 2014; Zerger et al., 2016). Recent studies (Larson et al., 2013; Larson et al., 2014; Zerger et al., 2016) have identified functional relationships between social positive contingencies (i.e., attention and interactive play) and increased levels of MVPA exhibited by preschool-aged children when compared to escape and nonsocial (i.e., alone) contingencies. Although researchers have demonstrated important functional relationships between MVPA and social consequences, the effect of access to tangibles on MVPA has not been examined. Tangible reinforcers, often delivered using an accumulated reinforcement arrangement or token economy, are used in clinical settings to decrease problem behavior and increase desirable, appropriate behavior. Contrary to a traditional tangible condition where access to a potential reinforcer is provided for 15 s or 30 s immediately following a target behavior, the use of an accumulated reinforcement arrangement allows for delayed but uninterrupted access to the reinforcer at the end of a session (DeLeon et al., 2014). It is possible some children might respond best (i.e., engage in higher levels of MVPA) if accumulated access to tangibles is made contingent on physical activity. To our knowledge, no research has been published on the evaluation of a tangible condition for MVPA. Thus, the purpose of the proposed study is to test the effects of token reinforcement on MVPA exhibited by preschool-aged children.

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