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Effects of extended intervention conditions on levels of physical activity exhibited by young children

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EFFECTS OF EXTENDED INTERVENTION CONDITIONS ON
LEVELS OF PHYSICAL ACTIVITY EXHIBITED BY YOUNG CHILDREN

By

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DEDICATION

This thesis is dedicated to my family and my husband for their endless support and patience. To my parents, thank you for always supporting me in everything that I have ever done in my life, I am the luckiest to have you two as my parents. To my little sisters, nothing has been more difficult than being away from home for so long, seeing you grow up at a distance and not being there. I am so proud of the young women you two have become. To my husband, thank you for pushing me when I needed it the most and for always being there for me. Takk fyrir allt, ég elska ykkur.

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Effects of Extended Intervention Conditions on
Levels of Physical Activity Exhibited by Young Children

Abstract

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2019

Physical activity is an important health-related behavior, and The Centers for Disease Control and Prevention (CDC) recommends that children engage in at least 60 minutes of moderate-to-vigorous-physical activity (MVPA) daily (CDC, 2015). However, worldwide, many children do not reach those requirements and health problems associated with physical inactivity are becoming more prevalent (CDC, 2015; World Health Organization [WHO], 2016). Recently, a few studies have conducted an intervention analysis to evaluate implications for function-based interventions to increase physical activity (Larson, Normand, Morley, & Miller, 2014; Zerger, Normand, Boga, & Patel, 2016). However, intervention analyses, indicate an overall decrease in levels of MVPA. This limitation could hinder further improvements of function-based interventions to increase physical activity, and is thus important to investigate. The current study partially replicated Zerger et al. (2016), and investigated the effects of alternating FA test conditions and repeated presentation of single condition exposure on maintenance of levels of MVPA in children. Additionally, the current study also evaluated the effectiveness of a more intermittent contingent schedules of reinforcement (i.e., fixed-interval limited-hold schedule) during intervention conditions. Results suggest it might be beneficial for caretakers and parents to deliver reinforcement in the form of social reinforcement to increase MVPA in preschool children. Additionally, the data suggest to promote MVPA, a more

intermittent schedule of contingent social reinforcement does not reliably promote stable levels of MVPA.

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Chapter 1: Introduction and Review of the Literature

Physical activity, broadly defined as any skeletal muscle movement resulting in energy expenditure (The Centers for Disease Control and Prevention [CDC], 2015; The World Health Organization [WHO], 2016), is an important health-related behavior (Janz et al., 2010; Sääkslahti et al., 2004). The American Heart Association (AHA), CDC, and WHO all emphasize the importance of regular physical activity (AHA, 2016; CDC, 2015; WHO, 2016). Conversely, physical inactivity is a worldwide problem associated with serious health risks, such as diabetes, cardiovascular disease, and stroke (CDC, 2015; Mavrovouniotis, 2012; Sääkslahti et al., 2004; WHO, 2016). Globally, an estimated 3.2 million deaths annually can be attributed to insufficient levels of physical activity (WHO, 2016). Physical inactivity is not only prevalent in adults, but also in children (WHO, 2016), and to combat this, the CDC recommends children engage in 60 min of moderate-to-vigorous physical activity (MVPA; e.g., running, climbing, jumping, fast cycling) every day. However, in 2008, Torino and colleagues reported that fewer than 50% of U. S. children aged 6-11 years met those requirements and more recently in 2016, the National Survey of Children's Health (NSCH) data query reported a further decrease and that only about 24% of children aged 6-17 years are reaching the 60-min requirement.

To date, multiple studies have investigated ways to increase physical activity in children using methods such as token economies, exergaming, and goal-setting and feedback (e.g., De Luca & Holborn, 1985, 1990, 1992; Fogel, Miltenberger, Graves, & Koehler, 2010; Hustyi, Normand, & Larson, 2011; Shayne, Fogel, Miltenberger, & Koehler, 2012; Patel, Normand, & Kohn, 2019). However, more recently, the functional analysis methodology has also been utilized to assess methods to increase physical activity in young children (Hustyi, Normand,

Larson, & Morley, 2012; Larson, Normand, Morley, & Hustyi, 2014; Larson, Normand, Morley, & Miller, 2013/2014; Zerger, Normand, Boga, & Patel, 2016).

The term *functional analysis* (FA) refers to the demonstration of a systematic relation between two variables (Hanley, Iwata, & McCord, 2003; Schlinger & Normand, 2013). More specifically, in applied behavior analysis, the term often is used to refer to a pre-intervention assessment (Iwata, Dorsey, Slifer, Bauman, & Richman, 1982, 1994) in which functional relations, usually between environmental events and problem behavior, are demonstrated empirically. The results of pre-intervention analyses are then used to inform subsequent behavioral interventions.

In the FA literature, some of the most commonly assessed behavior topographies are self-injurious behavior (SIB), aggression, and vocalizations (Beavers et al., 2013; Hanley et al., 2003). However, several studies have also used FA methods to identify the function of appropriate behaviors (Hustyi et al., 2012; Larson et al., 2013/2014; Normand, Machado, Hustyi, & Morley, 2011; Zerger et al., 2016), including physical activity (Hustyi et al., 2012; Larson et al., 2014; Larson et al., 2013/2014; Zerger et al., 2016).

For example, Larson, Normand, Morley, and Miller (2014), further refining the methodology of a previous study (i.e., Larson et al. 2013) conducted an FA similar to the experimental manipulations described by Iwata et al. (1982/1994), where participants were systematically exposed to four experimental conditions (i.e., attention, interactive play, demand, alone) and one control condition. Additionally, they also conducted a brief treatment analysis where participants were exposed to the same experimental condition repeatedly as would be the case during an intervention. The highest levels of MVPA occurred in the interactive play and attention conditions and during the brief treatment analysis, levels of MPVA were variable but

remained higher than baseline levels. However, for two participants, levels of MVPA were similar to those observed during the other FA conditions. Additionally, for at least one participant, a decreasing trend was suggested in the treatment analysis.

More recently, Zerger, Normand, Boga, and Patel (2016) replicated and extended the Larson et al. (2014) methodology and compared the condition that engendered the highest level of MVPA during the FA (i.e., contingent reinforcement condition) to a condition in which reinforcement was delivered according to a fixed-time (FT) schedule. The purpose of the comparison was to conduct an intervention analysis to determine if the FA contingency was the maintaining variable of MVPA, or if other variables were at play. During phase 1, an FA was conducted, replicating and extending the methodology described by Larson et al. (2014). During phase 2, participants were exposed to a contingent reinforcement (CR) condition (i.e., the condition that evoked the highest levels of MVPA during the FA), as well as a FT reinforcement condition. During the FT condition, reinforcement was delivered on a FT schedule based on the mean interresponse time (IRT) between instances of MVPA during the first few CR conditions and reinforcement was delivered for approximately 5 s regardless of MVPA occurrence. The results from the study supported previous results reported by Larson et al. (2013, 2014) and indicated that MVPA occurred most often in the attention and interactive play conditions for most participants. Additionally, for three of five participants, CR conditions evoked higher levels of MVPA than the FT conditions. However, for two participants, high levels of MVPA did not persist in the CR conditions or FT conditions during phase 2. These results are consistent with the results reported by previous studies (e.g., Larson et al. 2013) and provide valuable information about the use of the FA methodology to identify variables that produce high levels of MVPA and possible implications for function-based interventions. However, the same

limitation was identified as in Larson et al. (2014), and an overall decrease in levels of MVPA was observed within and across different intervention conditions. This decrease in MVPA can hinder further improvements of physical activity intervention analyses and is important to investigate to better establish and maintain high levels of MVPA in children. Therefore, the purpose of the current study was to continue assessing the influence of social consequences on MVPA, to assess the effects of alternating the FA test conditions and repeated presentation of a single condition, and to also evaluate the effectiveness of more intermittent contingent schedules of reinforcement during intervention conditions.

Chapter 2: General Method

Participants

Participants included 5 preschool-aged children with no reported developmental disabilities or other health conditions. Each participant's legal guardian read and signed an informed consent form and participants provided their assent after the experimenter presented the purpose and procedures of the study. The local institutional review board reviewed and approved all aspects of the study prior to participant recruitment.

Setting and Materials

Sessions were conducted at a local daycare where participants had access to a fixed play structure (i.e., a jungle gym) and an open grassy area. Sessions were conducted 1-5 days per week during times that the playground was not being used by other children. During all sessions, participants had access to an open grassy area, a swing, a fixed play structure, and outdoor toys (e.g., balls, hula hoops, Frisbees) were also be provided. Other materials included a timer to record the session length, and a form to track sessions and participant numbers. All sessions were recorded using a video camera.

Response Definition and Measurement

The primary dependent variable was MVPA, scored as a dichotomous variable based on the OSRAC-P activity codes (see Table 1). Following from previous research (e.g., Brown, et al., 2009; Hustyi et al., 2012; Larson et al., 2013) and the CDC's (2015) recommendation for children to engage in moderate and vigorous activities, MVPA was defined as OSRAC-P activity codes 4 (i.e., moderate movements) and 5 (i.e., fast movements). Activity codes were scored using a 1-s continuous partial-interval procedure in which MVPA was scored as "on" when

codes 4 or 5 were observed, and "off" when codes 1, 2, or 3 were observed. Activity codes were

scored on a desktop computer from video records using InstantData (Samaha, 2002).

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. (2009).

All sessions were video recorded and two independent observers collected data from the

video records. Interobserver agreement (IOA) was calculated by dividing the number of

agreements of the 1-s continuous partial-interval system, by the number of agreements plus

disagreements and multiplying by 100 to yield a percentage. An agreement was defined as both observers independently recording the occurrence or nonoccurrence of MVPA during the same 1-s interval. Interobserver agreement was calculated for 100% of sessions. Mean agreement across all participants was 94% for no-interaction sessions, 95% for Experiment 1, and 94% for Experiment 3. Interobserver agreement was also calculated for each participant. During no-interaction sessions mean agreement was 98% (range, 95% to 99%) for Jennifer, 99% (range, 98% to 100%) for Luke, 97% (range, 94% to 100%) for Prentiss, 97% (range, 86% to 100%) for Tara, and 96% (range, 95% to 100%) for Penelope. During Experiment 1, mean agreement was 95% (range, 89% to 100%) for Jennifer, 94% (range, 80% to 100%) for Luke, 94% (range, 84% to 100%) for Prentiss, 98% (range, 86% to 100%) for Tara, and 94% (range, 88% to 100%) for Penelope. During Experiment 3, mean agreement was 96% (range, 94% to 99%) for Jennifer, 93% (range, 86% to 100%) for Luke, and 93% (range, 90% to 97%) for Penelope.

Observer Training

Observers were trained graduate research assistants. Initially, the observers read relevant research articles (i.e., Brown, et al., 2009; Hustyi et al., 2012; Larson et al., 2013; Larson et al., 2014; Zerger et al., 2016) to review response definitions and data collection procedures (e.g., the OSRAC-P activity codes). Next, observers were tested on their understanding of the response definitions and data collection procedures via a short multiple-choice quiz and were required to earn a score of 80% or higher. Lastly, observers completed training on recording occurrence of MVPA using videos by practicing data collection using the InstantData software (Samaha, 2002). All videos used for the training had master data records, created by two trained observers, to which trainee performances were compared. First, the MVPA recording training included four videos with staged physical activity. Observers collected data on occurrences of

MVPA for all four videos and were required to reach 90% agreement with the master data records for each video. Second, the MVPA recording training included two sets of four videos with actual participants from previous studies on MVPA. Similar to the first step of data collection training, observers were provided with four videos and collected data on occurrences of MVPA. To meet criterion observers were required to reach 90% agreement with the master data records for each video. Third, after reaching criterion for all four videos, the last four videos were provided to observers in sets of two. To meet criterion for the first set of videos, observers were required to reach 90% agreement with the master data records for each video prior to gaining access to the last set of videos. Observer training was considered complete after observers completed both sets of videos and reached a minimum of 90% agreement with the master data records.

Procedural Integrity

Procedural integrity during Experiment 1 was defined as an independent observer recording the reinforcer delivery as "Correct" if the experimenter delivered the appropriate reinforcement within 2 s of the onset of MVPA. For Experiment 1, procedural integrity was collected for 26% of sessions in total, and the mean percentage was 94% (range, 89% to 97%) across all participants.

Procedural integrity was calculated for 20% of sessions for Jennifer with a mean of 97% (range, 86% to 100%), 22% of sessions for Luke with a mean of 95% (range, 80% to 100%), 22% of sessions for Prentiss with a mean of 89% (range, 83% to 95%), 33% of sessions for Tara with a mean of 93% (range, 92% to 93%), and 31% of sessions for Penelope with a mean of 96% (range, 89% to 100%).

Procedural integrity during Experiment 3 was defined as an independent observer recording the reinforcer delivery as "Correct" if the experimenter delivered the appropriate reinforcement within 2 s of the onset of MVPA. Additionally, the delivery of the FT reinforcer delivery was scored as "Correct" if the experimenter delivered appropriate reinforcement within 5 s of set reinforcement schedule. Data were collected for a minimum of 20% of randomly selected sessions per participant. For Experiment 3, procedural integrity was collected for 20% of sessions, in total and the mean percentage was 92% (range, 87% to 99%) across all participants.

Procedural integrity was calculated for 20% of sessions for Jennifer with a mean of 97% (range, 94% to 100%), 20% of sessions for Luke with a mean of 99% (range, 98% to 100%), and 20% of sessions for Penelope with a mean of 87% (range, 83% to 90%).

Procedure

All sessions were 5 min in length, and 1 to 3 sessions were conducted daily. During all sessions, participants had access to all areas of the playground (i.e., fixed play structure and open grassy area) and a variety of toys and activities (e.g., balls, hula hoops, Frisbees) were available to the participant.

Chapter 3: Experiment 1

The purpose of Experiment 1 was to identify the antecedent and consequent events that occasioned the highest level of MVPA and to evaluate whether MVPA would persist when participants were repeatedly exposed to the same condition.

Procedure

No-Interaction. The purpose of this condition was to measure the amount of MVPA exhibited prior to any experimental manipulations. This condition was conducted in the same manner as the no-interaction condition during the FA (described below), and the two conditions were compared across phases. Sessions were conducted until a stable pattern of MVPA was observed across 3 consecutive sessions. The experimenter guided the participant to the session area and stated, "I am going inside to talk to your teacher. You can play out here until I come back." The experimenter then left the session area and remained out of sight during the session. The cameraperson remained outside with the participant to provide supervision and record the session. During this condition, no attention or consequences were delivered contingent on MVPA.

Functional Analysis. The FA was a partial replication of Zerger et al. (2016); however, the no-interaction condition served as a control condition from which to compare levels of MVPA across experimental conditions. The FA was arranged according to a multielement experimental design and sessions were conducted until the data were differentiated, or until a total of 4 to 5 sessions were conducted for each FA condition.

Attention. The purpose of this condition was to identify whether social positive reinforcement in the form of adult attention could produce higher levels of MVPA compared to no-interaction conditions when social reinforcement was not available. The experimenter guided

the participant to the session area and stated, "If you run, jump, or climb, I will talk to you. But if you don't, I'll have to do some work." Contingent on MVPA, the experimenter delivered approximately 5 s of attention specific to the participant's ongoing activity, while the participant continued to engage in MVPA (e.g., "Good job running!"). After 5 s of attention, if the participant continued engaging in MVPA, the experimenter continued delivering attention according to a FT 5-s schedule for as long as MVPA persisted. When the participant was not engaging in MVPA, the experimenter appeared busy and delivered no verbal (e.g., praise) or nonverbal (e.g., eye contact, shoulder touch) attention.

Interactive Play. The purpose of this condition was to determine whether social positive reinforcement in the form of physical interaction produced higher levels of MVPA compared to no-interaction conditions. During the interactive play condition, the experimenter guided the participant to the session area and stated, "If you run, jump, or climb, I will play with you. But if you don't, I'll have to do some work." Interactive play was delivered according to the same schedule described during the attention condition. For example, if the participant began running on the playground, the experimenter would run with the participant for 5 s while delivering praise specific to the ongoing activity. Additionally, to control for verbal attention delivered during the interactive play, brief statements specific to the experimenter's current behavior were delivered (e.g., "I am walking here in the grass!") according to an FT 30-s schedule. When the participant was not engaging in MVPA, the experimenter would appear busy and deliver no verbal (e.g., praise) or nonverbal attention (e.g., eye contact, shoulder touch), or play.

No-Interaction. The purpose of this condition was to identify whether MVPA occurred in the absence of social contingencies. This condition served as a control condition to compare conditions in which social reinforcement was available (i.e., attention condition, interactive play

condition) and when social reinforcement was not available (i.e., no-interaction condition). The experimenter guided the participant to the session area and stated, "I am going inside to talk to your teacher. You can play out here until I come back." The experimenter then left the session area and remained out of sight during the session. The cameraperson remained outside with the participant to provide supervision and record the session. No programmed consequences were delivered contingent on MVPA.

Intervention. The purpose of this phase was to evaluate if levels of MVPA maintained elevated when participants were repeatedly exposed to the same condition, as would be the case during an intervention based on the results of the FA. During this phase, the participant was exposed to the FA condition that evoked the highest level of MVPA, until a stable level of MVPA was observed across three consecutive sessions, or until a decreasing trend was observed.

Chapter 4: Experiment 1 Results and Discussion

Figure 1 displays the percentage of intervals during which participants engaged in MVPA during no-interaction and FA for all participants. Figure 1 also displays the percentage of intervals during which Jennifer, Luke, and Penelope engaged in MVPA during the intervention phase during Experiment 1. Due to limited number of data points, unclear results, and time restraints due to the end of the school year preventing further FA session data collection, Prentiss and Tara were not included in the intervention phase.
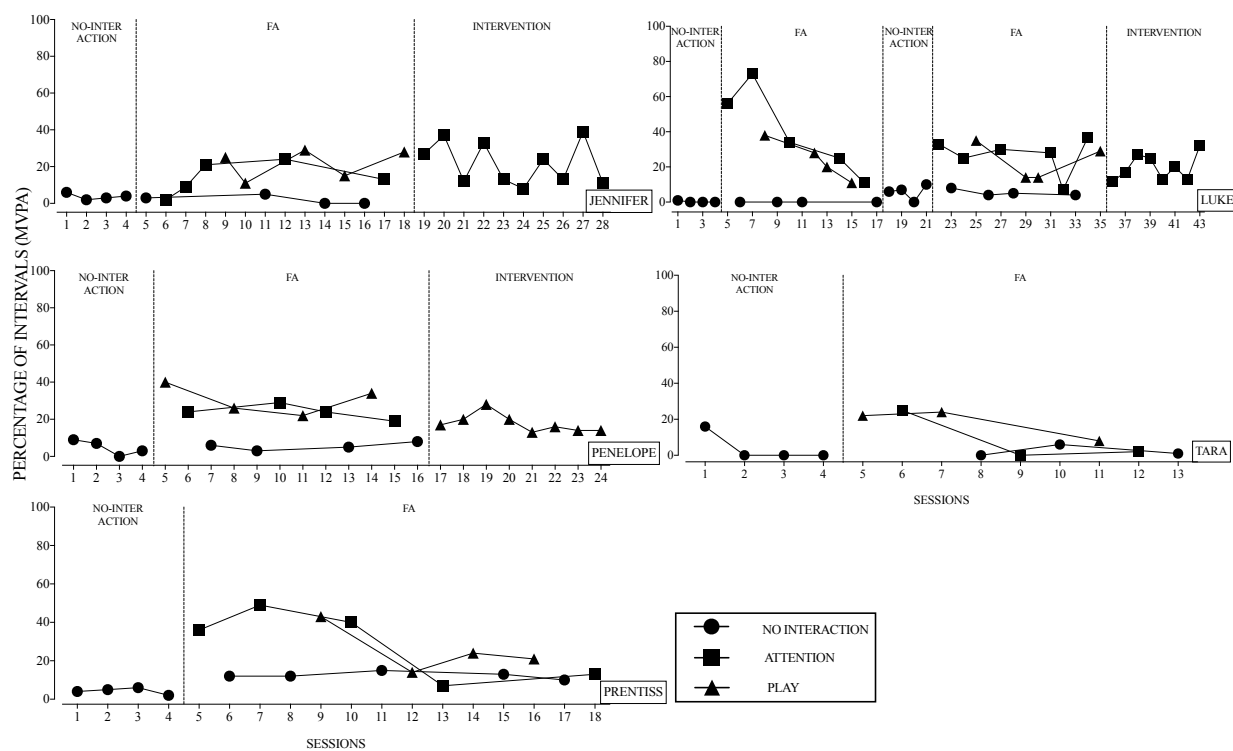

Figure 1. Percentage of intervals with moderate-to-vigorous physical activity (MVPA) observed across Experiment 1, for Jennifer, Penelope, Luke, Tara, and Prentiss.

During no-interaction, low levels of MVPA were observed for all participants. For Jennifer, Penelope, Prentiss, Tara, and Luke the average percentage of intervals during which participants engaged in MVPA was 4% (range, 2% to 6%), 5% (range, 0% to 9%), 4% (range, 2% to 5%), 4% (range, 0% to 16%), 0.3% (range, 0% to 1%) and 6% (range, 0% to 10%) during the second baseline condition for Luke, respectively.

During the FA, Jennifer and Penelope (Figure 1) engaged in most MVPA during the interactive play conditions, as compared to no-interaction conditions, and the average percentage of intervals during which they engaged in MVPA was 22% (range, 11% to 29%) for Jennifer and 31% (range, 22% to 40%) for Penelope. For Luke, during the FA levels of MVPA were on a decreasing trend and reached low levels (i.e., 11%) during sessions 15 and 16. It should be noted that all FA sessions were conducted across multiple different days and the decreasing trend continued across multiple days. Subsequently, a second no-interaction phase and FA were conducted and produced differentiated results. During the second FA, Luke engaged in most MVPA during attention conditions and the average percentage of intervals during which he engaged in MVPA was 27% (range, 7% to 37%). For Prentiss and Tara during the FA, overall undifferentiated results were observed. For Prentiss, levels of MVPA were elevated during the first few FA sessions but then decreased and maintained at similarly low levels during the last 2-3 sessions for all conditions (i.e., no-interaction, attention, and interactive play) and unclear results were observed. Similarly, for Tara, levels of MVPA across all experimental conditions (i.e., no-interaction, attention, and interactive play) were low and during the last six sessions of the FA near zero levels were observed.

During intervention, elevated levels of MVPA were observed for the three participants (Jennifer, Luke, Penelope), and were similar to levels observed during the FA. The average

percentage of intervals during which Penelope, Jennifer, and Luke engaged in MVPA during intervention was 18% (range, 13% to 28%), 22% (range, 12% to 32%), and 20% (range, 12% to 32%), respectively.

The results for the no-interaction phase of Experiment 1 indicate low to zero average levels of MVPA for all participants (i.e., range, 0% to 6%) and are similar to the average baseline levels observed by Larson et al. (2014; range, 4% to 14%). Additionally, results of the FA phase indicated differentiated responding for 3 of 5 participants (Jennifer, Luke, Penelope), with levels of MVPA generally highest in the attention and interactive play conditions. However, levels of MVPA in the test conditions varied within and across participants; the FA did not produce differentiated results for 2 participants (Prentiss, Tara).

Overall the FA results are similar to those reported by Larson et al. (2014) and Zerger at al. (2016) insofar as levels of MVPA were generally highest in the attention and interactive play conditions and differentiated FA results were indicated for 4 of 4 participants and 5 of 7 participants, respectively. Table 2 lists the average levels of MVPA during no-interaction conditions and the FA condition that evoked the highest level of MVPA and was used during intervention phases. For Jennifer, Luke, and Penelope, average levels of MVPA during no-interaction conditions were 4% (range, 2% to 6%) and increased to an average of 24% (range, 14% to 31%) during FA conditions that evoked the highest levels of MVPA. For Luke, there could be a variety of reasons why the first FA did not result in differentiation but the second FA did. For example, the experimenter conducted sessions during different times in the mornings and it could be that during the first FA Luke was more interested in activities that were occurring inside the classroom rather than participating in sessions. Also, throughout the study the experimenter tried to build rapport with participants and engage with them in the classroom

outside of sessions and it could be that gradually the experimenter's attention started to function as a reinforcer.

Table 2

Average Percentage of Moderate to Vigorous Physical Activity (MVPA) and Mean Baseline Increase

Participant	Intervention	Average % MVPA (N)			Range (%)			MBLI (%)	
		BL/NI	FA	TX	BL/NI	FA	TX	FA	TX
Larson et al. (2014)									
Grace	Interactive Play	38(3)	75(3)	64(3)	32-43	70-82	51-72	97	68
Greta	Interactive Play	16(3)	60(3)	44(3)	1-45	41-72	36-51	275	175
Vivien	Interactive Play	19(3)	48(3)	60(3)	0-38	44-50	54-69	153	216
Humphrey	Interactive Play	17(3)	44(3)	25(3)	13-36	39-52	24-43	159	47
Zerger et al. (2016)									
Liam	Attention	16(3)	38(4)	24(18)	8-31	23-60	9-44	138	50
Frank	Attention	32(5)	50(5)	62(9)	20-47	32-68	43-79	56	94
Sheila	Attention	19(3)	54(3)	40(17)	9-34	48-64	21-67	184	111
Carl	Interactive Play	15(3)	37(3)	28(13)	9-19	37-38	14-45	147	87
Current study									
Jennifer	Attention	2(4)	14(5)	20(11)	0-5	2-24	7-39	600	900
Luke	Attention	3(8)	27(6)	18(12)	0-8	7-37	0-32	800	500
Penelope	Interactive Play	6(4)	31(4)	19(14)	3-8	13-35	13-35	417	217

Note. N = number of data points used for calculation for each phase; BL/NI = baseline or no-interaction; FA = FA condition that was used during intervention conditions; TX = all intervention conditions for the condition that evoked highest levels of MVPA. MBLI = mean baseline increase. MBLI was calculated by subtracting the mean level of MVPA for FA/intervention from the mean baseline level of MVPA during no-interaction/baseline conditions, dividing that number by that mean baseline level of MVPA during no-interaction/baseline conditions, and multiplying by 100.

The mean baseline increase (MBLI)[1] was calculated for each participant for the FA condition by subtracting the mean of all data points in the FA condition that evoked the highest level of MVPA from the mean of all data points in the no-interaction condition of the FA, dividing by the mean no-interaction conditions, and multiplying by 100. There was an overall increase in levels of MVPA during FA test conditions (attention or interactive play), and the MBLI was 600% for Jennifer, 800% for Luke, and 417% for Penelope. This is also similar to the results indicated by Larson et al. (2014) and Zerger et al. (2016), where the overall increase in MVPA between no-interaction and FA conditions (i.e., attention or interactive play conditions) was 34% (range, 27% to 44%) and 24% (range, 18% to 35%), and MBLI averaged at 171% (range, 97% to 275%) and 106% (range, 56% to 184%), respectively.

However, it is important to note that when comparing levels of MVPA across different studies, the levels of MVPA during the no-interaction conditions for the Larson et al. (2014) and Zerger et al. (2016) were higher, overall, than in the current study. This could be due to a variety of reasons, such as weather differences; for example, data for Zerger et al. (2016) were collected during the spring and the weather gradually got warmer during the course of the study, while data for the current study were collected during the fall and the weather got gradually colder with more rain. Also, the studies were conducted on different playgrounds with slightly different toys available. The playground for Zerger et al. (2016) did not include a sandbox or a swing; however, the current study included a small area with mulch where participants played with sandbox toys and the playground also included a swing. Both playing with sandbox toys and swinging are activities that do not fall under codes 4 or 5 (i.e., MVPA) of the OSRAC-P activity

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[1] Campbell (2003; see also Heyvaert, Saenen, Campbell, Maes, & Onghena, 2014; Slaton & Hanley, 2018) reported calculations for mean baseline reduction (MBLR). Due to the focus of this study on increasing MVPA, we calculated an MBLI using the same basic calculation but focused on the increase from baseline (i.e., no-interaction condition).

codes and could result in overall lower levels of MVPA if participants spent their time engaging with those activities.

For all 3 participants (Jennifer, Luke, Penelope) levels of MVPA varied between and within participants during intervention, but overall maintained at a higher level then observed for the control condition during the FA and no-interaction. During the intervention phase of Experiment 1, the average levels of MVPA were 22% (range, 8% to 39%) for Jennifer, 20% (range, 12% to 32%) for Luke, and 18% (range, 13% to 28%) for Penelope. Although levels of MVPA were elevated, they were overall lower during the intervention condition for Luke and Penelope and averaged at 20% (range, 12% to 32%) and 18% (range, 13% to 28%), as compared to levels of MVPA observed during the FA that averaged at 27% (range, 7% to 37%) and 31% (range, 22% to 40%). For Jennifer, even though overall levels of MVPA were the same during the FA and intervention phase (i.e., 22%), there was more variability in MVPA during the intervention phase. Even though the increase in variability could have resulted from repeated exposure to the intervention, it might also be a byproduct of the greater number of sessions conducted during the intervention phase than during the FA.

The results of the intervention phase are similar to the results indicated by Larson et al. (2014) and Zerger et al. (2016) in that levels of MVPA maintained at overall elevated levels during the intervention phase as compared to no-interaction. conditions. That is, the average level of MVPA during intervention for all participants was 20% (range, 8% to 39%) in the current study, 48% (range, 25% to 64%) for Larson et al. (2014), and 39% (range, 28% to 62%) for Zerger at al. (2016). However, the average level of MVPA during no-interaction conditions was 4% (range, 2% to 6%) in the current study, 23% (range, 16% to 38%) for Larson et al. (2014), and 21% (range, 15% to 32%) for Zerger et al. (2016). Additionally, and similar to the

results of the current study, although MVPA persisted at elevated levels during the intervention phase, there was a decrease in overall levels of MVPA from the levels observed during the FA for both Larson et al. (2014) and Zerger et al. (2016). This might be evidence of interaction effects resulting from the multielement design of the FA; rapidly alternating between different intervention and control conditions might result in more MVPA than repeated exposure to the same condition. However, as noted by Hains and Baer (1989), this might actually be a desirable model with real-world generality as the rapid alternation (e.g., between no attention, attention, and interactive play) is something that might occur in the natural setting (e.g., going to a playground with a parent).

Results of the FAs are consistent with the results reported by Larson et al. (2014) and Zerger et al. (2016), in which the highest levels of MVPA were observed during the attention and interactive play conditions for most participants. These results provide further support that social positive reinforcement in the form of attention or interactive play can increase overall levels of MVPA for children. Additionally, the results of the intervention phase of Experiment 1 also are consistent with the results reported by Larson et al. (2014) and Zerger et al. (2016) and suggest that when repeatedly exposed to the same contingency, levels of MVPA may vary but still remain elevated, overall, as compared to when the contingencies are not in place (i.e., no-interaction conditions).

Chapter 5: Experiment 2

Experiment 2 was to include participants from Experiment 1 for which a decreasing trend was observed during the intervention phase of Experiment 1. The purpose of Experiment 2 was to evaluate if the levels of MVPA during the initial FA could be replicated and a second FA was to be conducted. Because we did not observe any decreasing trends in MVPA for any participants included in the intervention phase of Experiment 1 (Jennifer, Luke, Penelope), no participants were included in Experiment 2.

Chapter 6: Experiment 3

Experiment 3 included participants for which MVPA persisted during the intervention phase of Experiment 1. The purpose of Experiment 3 was to evaluate whether MVPA would persist when a more intermittent reinforcement schedule was implemented. If MVPA did not persist, a second intervention phase identical to that in Experiment 1 was conducted.

Procedure

Fixed-interval limited-hold schedule. In the fixed-interval limited-hold schedule (FI-LH) procedure, the participants were observed, data were collected, and a reinforcer delivered (if applicable) at the end of a predetermined time period (Cooper, Heron, & Heward, 2007). As compared to the intervention phase of Experiment 1, where participants were monitored continuously and the reinforcer was available and delivered contingent on every occurrence of MVPA. During Experiment 3, the FI schedule was based on the mean IRT between recorded instances of MVPA in the intervention phase of Experiment 1. That is, the number of seconds between the end of each bout of MVPA and beginning of the next bout of MVPA was recorded, with each bout lasting for 1 s or longer, as long as the participant continued to engage in MVPA. Additionally, a LH of 5 s was chosen. For example, if the mean IRT for a participant was 20 s, the experimenter observed the participant at the end of each 20 s interval. That is, at the beginning of a session, after 20 s elapsed the experimenter would observe the participant for 5 s and contingent on MVPA deliver consequences in the same manner as in the intervention phase of Experiment 1. Immediately following each 5-s observation interval, the next 20 s interval begun. No programmed consequences were delivered contingent on MVPA that initially occurred outside of the 5-s LH interval. The FI-LH procedure is similar to a momentary-time sampling data collection procedure (Cooper, Heron, & Heward, 2007) and was chosen to try

keeping the implementation of the procedure as simple as possible and would be a procedure that might be more feasible for a parent or a teacher to implement on a playground or during recess.

Intervention. The intervention phase included participants for whom a decreasing trend or overall lower levels of MVPA were observed during the FI-LH. The intervention phase was identical to the intervention phase conducted in Experiment 1.

Chapter 7: Experiment 3 Results and Discussion

Figure 2 displays the percentage of intervals during which participants engaged in MVPA during Experiment 3. Three participants (Jennifer, Luke, Penelope) were included in Experiment 3 based on results from Experiment 1 demonstrating that elevated levels of MVPA persisted during the intervention phase. For all participants (Jennifer, Luke, Penelope), during the FI-LH phase, based on visual analysis levels of MVPA were overall lower than levels observed during intervention phase of Experiment 1. MVPA occurred less often, overall, during the Intervention phase of Experiment 1 for all participants. For Jennifer, during the FI-LH phase levels of MVPA were less variable and had fewer spikes as compared to the levels observed during the Intervention phase of Experiment 1. However, MVPA still was higher than during control conditions in the FA. For Penelope, it was the opposite; during the FI-LH phase, levels of MVPA were more variable as compared to the Intervention phase and varied between levels similar to control conditions and levels observed during the Intervention phase of Experiment 1. For Luke, levels of MVPA were on a decreasing trend and reached zero levels during the last FI-LH session.

During the intervention phase of Experiment 3, when exposed to a replication of the previous intervention phase (i.e., from Experiment 1), for Luke and Penelope levels of MVPA increased again to similar levels observed during the intervention phase of Experiment 1. That is, percentage of intervals during which MVPA was observed during the intervention phase of Experiment 3 increased to an average of 13% (range, 0% to 19%) for Luke and 20% (range, 15% to 35%) for Penelope. For Jennifer, due to the school year ending only one session was conducted during the intervention phase of Experiment 3 and levels of MVPA were at 7%.
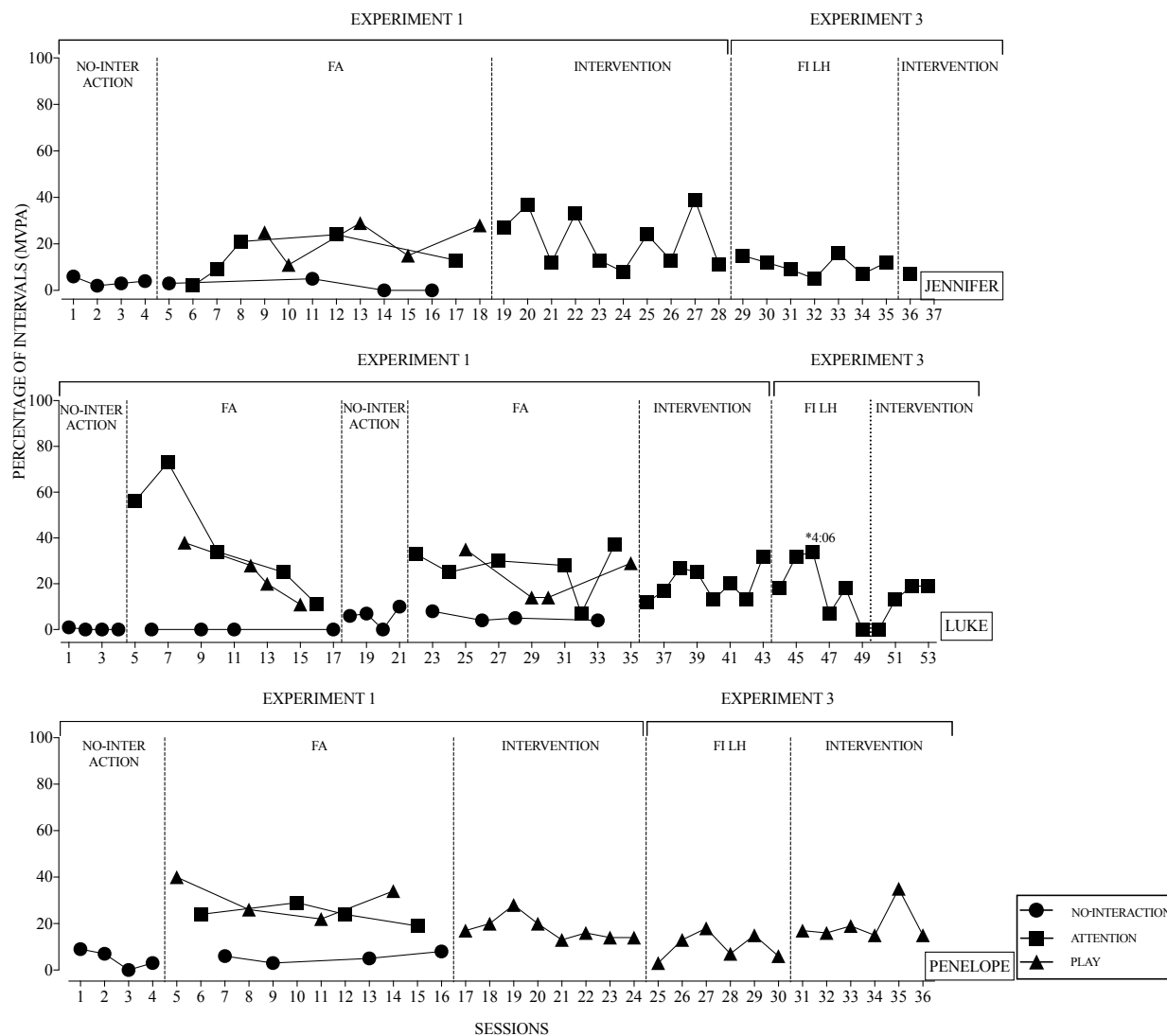
Figure 2. Percentage of intervals with moderate-to-vigorous physical activity (MVPA) observed across Experiment 1 and Experiment 3, for Jennifer, Luke, and Penelope. The asterisk for sessions 46 for Luke denotes a shortened session duration due to a timer error.

These results are similar to results reported by Zerger et al. (2016) during an intervention analysis, where participants were exposed to social reinforcement (attention or interactive play) on a contingent scheduled and a FT schedule. During the FT schedule, levels of MVPA for all

participants decreased compared to the contingent reinforcement schedule. The current study attempted to extend the Zerger et al. (2016) intervention analysis by implementing a FI-LH schedule. During the FI-LH phase, levels of MVPA varied between and within participants and were overall lower than levels of MVPA observed during the intervention phase of Experiment 1, similar to the results reported by Zerger et al. (2016) during FT conditions of the intervention analysis. This decrease in MVPA could be a result of the method used to set the FI schedule and due to the overall variability in levels of MVPA across the FA sessions used to calculate the IRT. Future studies should investigate other schedules (e.g., variable schedules) and ways to set the schedule to better maintain high levels of MVPA.

During the FI-LH phase levels of MVPA averaged at 11% (range, 5% to 16%) for Jennifer and 18% (range, 0% to 34%) for Luke, but during intervention phase of Experiment 1 levels of MVPA average at 22% (range, 8% to 39%) for Jennifer and 20% (range, 12% to 32%) for Luke. Penelope exhibited low and variable levels of MVPA during the FI-LH phase, ranging between levels similar to control and test conditions and averaging at 10% (range, 3% to 18%), as compared to 18% (range, 13% to 28%) during the intervention phase of Experiment 1.

During a replication of the intervention phase in Experiment 3, for 2 out of 3 participants (Luke and Penelope) levels of MVPA increased again to levels similar to the intervention phase during Experiment 1. Because a limited number of sessions were conducted during the intervention phase of Experiment 3 for Jennifer, Luke, and Penelope, due to the end of the school year, it is difficult to determine if levels of MVPA would have maintained for an extended period of time.

Results from the intervention analysis support the results of previous studies (i.e., Zerger et al., 2016) and suggest that the contingent relation between attention or physical interaction and

MVPA is important. That is, to maintain MVPA at elevated levels, attention or physical interaction should be provided contingent on every instance of MVPA whenever feasible. If not delivered following every instance of MVPA, levels of MVPA might decrease overall and eventually reach near zero levels.

Chapter 8: General Discussion

Results of this study replicated those of Larson et al. (2014) and Zerger et al. (2016) and demonstrated that the FA methodology identified social reinforcement contingencies that evoked MVPA in preschool-aged children, with differentiation between FA conditions for 3 out of 5 participants (Jennifer, Luke, Penelope). The results also suggest that, when those social reinforcement contingencies are used during intervention and participants are repeatedly exposed to the same contingency, levels of MVPA may vary but still remain elevated, overall, as compared to when the contingencies are not in place (i.e., no-interaction conditions). Furthermore, the findings suggest that when those social contingencies are implemented according to a more variable, but still contingent schedule, variability in levels of MVPA might increase and levels of MVPA can decrease to levels similar to no-interaction conditions.

For Jennifer, Luke, and Penelope, levels of MVPA maintained during the intervention phase of Experiment 1 and, as presented in Table 2, MBLI calculations indicated an average increase of 539% (range, 217% to 900%). This MBLI is higher than results reported by Larson et al. (2014) and Zerger et al. (2016), where the average MBLI was 127% (range, 47% to 216%) and 86% (range, 50% to 111%), respectively. However, it is important to note for the current study that the larger MBLI percentage does not necessarily mean that participants engaged in more MVPA as compared to the Larson et al. (2014) and Zerger et al. (2016) participants. This is due to the difference in initial levels of MVPA during no-interaction conditions, with overall levels for the current study lower (range, 2% to 6%) than levels reported by Larson et al. (2014; range, 16% to 38%) and Zerger et al. (2016; range, 15% to 32%).

Although these levels of MVPA do not meet the 60-min MVPA recommendation reported by the CDC and future research should aim to increase levels of MVPA even further,

the increase still brings the levels of MVPA closer to that goal. In fact, the Office of Disease Prevention and Health Promotion (ODPHP) updated the Physical Activity Guidelines for Americans and one of the changes made from the 2008 guidelines was that, instead of an activity needing to last 10 min to count towards the daily activity recommendation, the new guidelines state that any activity length (e.g., walking up a flight of stairs) counts toward the daily goal (ODPHP, 2018).

Although the results of the current study are promising, several limitations should be noted. First, for two participants (Prentiss, Tara) the FA did not result in differentiated responding across conditions, indicating that social reinforcement might not have functioned as a reinforcer for those participants. For Tara, MVPA was initially low and then decreased to zero levels across all conditions. During sessions in which Tara was not engaging in MVPA, she mostly played with sandbox toys. Similarly, for Prentiss, the FA did not result in differentiated responding across conditions.

However, levels of MVPA during the FA were somewhat elevated across all conditions, which might suggest interaction effects between conditions. For participants like Prentiss, future studies might implement an extended alone condition (Vollmer, Iwata, Duncan, & Lerman, 1993) to eliminate the methodological problem of elevated levels of MVPA due to interaction effects between conditions, and evaluate whether levels of MVPA remain overall elevated in the absence of social contingencies. However, for participants like Tara, who engaged in low levels of MVPA, overall, future studies might consider assessing participants fundamental movement skills to determine if participants might have skill deficits related to physical activity. Fundamental movement skills are a specific set of skills that involve different body parts (e.g., legs, arms, trunk, arms) and movements (e.g., jumping, hopping, running) and scoring higher on

those skills has been associated with more physical activity in children (Holfelder & Schott, 2014). Assessing participants fundamental movement skill level and teaching them the skills they need might help increase MVPA.

Second, during sessions when participants were not engaging in MVPA, participants often engaged with sedentary activities such as sandbox toys (e.g., Tara). These anecdotal observations support the results and recommendations of previous studies (Boga & Normand, 2017; Hustyi et al., 2012) that suggest access to outdoor toys evokes lower levels of MVPA than fixed equipment or open space. Additionally, it supports the recommendation that during times when the primary goal is to promote higher levels of MVPA (e.g., recess), it could be helpful to promote activities that in the past evoked higher levels of MVPA and limit activities that in the past have not evoked higher levels of MVPA. For example, for Tara, MVPA might have increased if access to sandbox toys would be made contingent on a certain amount of MVPA during sessions. Therefore, future research might further investigate the possible influence of availability of different toys or activities on levels of MVPA.

Third, as previously mentioned, although overall levels of MVPA during the intervention phase were elevated, they were still somewhat low, averaging at 22% for Jennifer, 20% for Luke, and 18% for Penelope. The levels of MVPA during the intervention phase translate to approximately 1 min of overall MVPA during a 5-min session (i.e., 1 min 6 s for Jennifer, 1 min for Luke, 54 s for Penelope) and future research should aim to continue increasing levels of MVPA even further, to bring the levels closer to the 60-minute daily goal recommended by the CDC and other public health agencies. Also, a limited number of sessions were conducted for the second intervention phase for three participants (Jennifer, Luke, Penelope). Because of this,

it is difficult to determine if levels of MVPA would have persisted at similar levels for an extended period of time.

In summary, the current study assessed the effects of alternating FA test conditions and repeated presentation of a single condition and evaluated the effectiveness of a more intermittent contingent schedule of reinforcement during intervention conditions. Similar to previous studies (e.g., Larson et al. 2014; Zerger et al., 2016), the results suggest it might be beneficial for caretakers and parents to deliver reinforcement in the form of social interactions to increase MVPA in preschool-aged children. Additionally, the data suggest that alternating between different forms of social reinforcement (i.e., attention and interactive play) and no social reinforcement (i.e., no attention) might result in overall more MVPA than repeated exposure to the same condition. Furthermore, for social reinforcement, a more intermittent schedule of contingent reinforcement does not seem to reliably promote MVPA. Therefore, to promote MVPA, it is not only important to deliver social reinforcement on a contingent reinforcement schedule, but on a continuous reinforcement schedule whenever feasible.

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APPENDIX A: THESIS PROPOSAL

Physical activity, broadly defined as any skeletal muscle movement resulting in energy expenditure (The Centers for Disease Control and Prevention [CDC], 2015; The World Health Organization [WHO], 2016), is an important health-related behavior (Janz et al., 2010; Sääkslahti et al., 2004). The American Heart Association (AHA), CDC, and WHO all emphasize the importance of regular physical activity (AHA, 2016; CDC, 2015; WHO, 2016). Conversely, physical inactivity is a worldwide problem associated with serious health risks, such as diabetes, cardiovascular disease, and stroke (CDC, 2015; Mavrovouniotis, 2012; Sääkslahti et al., 2004; WHO, 2016). Globally, an estimated 3.2 million deaths annually can be attributed to insufficient levels of physical activity (WHO, 2016). Physical inactivity is not only prevalent in adults, but also in children (WHO, 2016), and to combat this, the CDC recommends children engage in 60 min of moderate-to-vigorous physical activity (MVPA; e.g., running, climbing, jumping, fast cycling) every day; however, in 2008, Torino and colleagues reported that less than 50% of U. S. children aged 6-11 years met those requirements.

To date, multiple studies have investigated ways to increase physical activity in children using methods such as token economies, exergaming, and goal-setting and feedback (e.g., De Luca & Holborn, 1985, 1990, 1992; Fogel, Miltenberger, Graves, & Koehler, 2010; Hustyi, Normand, & Larson, 2011; Shayne, Fogel, Miltenberger, & Koehler, 2012). However, only a handful of studies have attempted to assess the specific function of physical activity by systematically manipulating variables under controlled conditions (Larson, Normand, Morley, & Miller, 2013, 2014; Hustyi, Normand, Larson, & Morley, 2012, Zerger, Normand, Boga, &

Patel, 2016) and even fewer studies have assessed the effectiveness and maintenance of function-based interventions for physical activity (Larson, Normand, Morley, & Miller, 2014; Zerger, Normand, Boga, & Patel, 2016). Thus, further research aimed at identifying function-based methods to increase and maintain physical activity is warranted.

Functional Assessments of Behavior

The term *functional analysis* refers to the demonstration of a systematic relation between two variables (Hanley, Iwata, & McCord, 2003; Schlinger & Normand, 2013). More specifically, in applied behavior analysis, the term often is used to refer to a pre-intervention assessment (Iwata, Dorsey, Slifer, Bauman, & Richman, 1982, 1994) in which functional relations, usually between environmental events and problem behavior, are demonstrated empirically. The results of pre-intervention analyses are then used to inform subsequent behavioral interventions.

The standard pretreatment functional analysis (FA) methodology, often referred to as an ABC functional analysis (e.g., Hanley, Iwata, & McCord, 2003), was developed by Iwata et al. (1982/1994) and involves the manipulation of antecedent variables and consequent events under controlled conditions to evaluate the effects on a target behavior. In the seminal Iwata et al. (1982/1994) study, eight participants with developmental disabilities who engaged in various forms of severe self-injurious behavior (SIB) were exposed to three experimental conditions (social disapproval, academic demand, alone) and a single control condition (unstructured play). Each session in each condition was 15 min long, and sessions were arranged according to a multielement design.

In the Iwata et al. (1982/1994) FA, specific antecedent and consequent events were arranged for each condition. Each test condition was arranged to assess a particular type of

reinforcement contingency (social positive, social negative, automatic). During social

disapproval conditions, participants received access to moderately preferred items while

experimenters withheld all attention and pretended to be busy. Contingent on problem behavior,

experimenters delivered attention in the form of social disapproval statements (e.g., "Don't do

that."). The purpose of this condition was to determine if problem behavior was maintained by

social positive reinforcement. During academic demand conditions, continuous demands were

placed on the participants, in the absence of problem behavior. Contingent on problem behavior,

all demands were removed for 30 s. The purpose of this condition was to determine if the

problem behavior was maintained by social negative reinforcement (i.e., escape from demands).

During alone conditions, participants were left alone in the session room for the duration of the

session, without access to toys or other materials. The purpose of this condition was to

determine if the behavior was automatically maintained. During unstructured play (i.e., control)

conditions, no academic tasks were presented, and a variety of toys were available. Throughout

the session, the experimenter delivered non-contingent reinforcement once every 30 s in the form

of praise and physical contact; problem behavior did not result in any programmed

consequences. Results demonstrated that the levels of SIB varied between and within

participants, and that levels of SIB were higher in specific experimental conditions compared to

the control condition.

In 1992, Derby et al. reported a summary of 79 cases evaluating the utility of FAs

conducted in outpatient settings. Results indicated when the target behavior occurred during the

assessment, a maintaining variable was identified 74% of the time and, for 77% of evaluations,

when the maintaining variables were manipulated, a decrease in aberrant behavior or increase in

appropriate behavior occurred. Furthermore, Hanley et al. (2003) reported the results of a

literature review of FA research that included studies published through the year 2000. In the review, 536 graphed individual datasets were identified as published results for FAs. Out of those graphs, 96% were interpreted to demonstrate differentiated outcomes. More recently, Beavers, Iwata, and Lerman (2013) published an updated literature review and reported that differentiated results were obtained for 94% of cases.

Moreover, Thompson and Iwata (2007) compared the results of descriptive analyses and FAs for 12 individuals. Their results indicated that during descriptive analyses, attention was identified as the maintaining variable for 75% of cases, however, during the FAs, attention was identified as the maintaining variable for only 16.7% of cases. These results support the utility of the ABC FA as an assessment method, to more accurately identify the function of behavior, over other assessment methods, such as descriptive analyses (e.g., Hanley, Iwata, & McCord, 2003). However, despite its utility, many professionals within the field of behavior analysis do not use the FA method; a recent web-based survey about the use of various functional assessment methods reported by behavior analysts in practice, most respondents reported that they "never" or "almost never" use FA methods to identify the function of behaviors (Oliver, Pratt, & Normand, 2015), but instead rely on descriptive assessments. In the physical activity literature, many researchers also appear to use descriptive analyses; only a handful of studies utilize the FA methodology to identify the function of physical activity (Hustyi, Normand, Larson, & Morley, 2012; Larson, Normand, Morley, & Hustyi, 2014; Larson, Normand, Morley, & Miller, 2013/2014; Zerger, Normand, Boga, & Patel, 2016). This is a problem because descriptive analyses are poor predictors of behavioral function, especially when compared to the outcomes of FAs (e.g., Pence, Roscoe, Bourret, & Ahearn, 2009; Lerman & Iwata, 1993; Thompson & Iwata, 2007). Thus, it is important to further the research of physical activity using

FA methodology to demonstrate functional relations and inform function-based interventions to, hopefully, increase and maintain physical activity.

Experimental Designs for FAs

To identify a functional relation between independent and dependent variables, conditions are arranged that produce change in the dependent variable as a result of change in the independent variable. However, the changes in the independent variable must precede changes in the dependent variable more than once in order to demonstrate experimental control. For example, if one test condition reliably produces the highest rate of target behavior as compared to other conditions during an FA, the antecedent and consequence of the condition are said to be functionally related to the target behavior. Different experimental designs have been used to systematically alternate test conditions, but the three most common experimental arrangements reported in published research involving FAs are reversal, multielement, and pairwise designs (Beavers et al., 2013; Hanley et al., 2003).

Reversal designs examine the effects of an independent variable on a target behavior by comparing conditions during which an independent variable is absent or present. At least three phases are required (ABA), and sessions for each phase are typically conducted until stable responding is observed. The initial phase (A) serves as a baseline where the independent variable is absent. During the second phase (B), the independent variable is introduced. The reversal is accomplished during the third phase, when the independent variable is withdrawn and a second baseline (A) phase is conducted. Additionally, to further strengthen experimental control, a repetition of the second phase (B) is recommended to replicate the effect of the independent variable (i.e., an ABAB design; Cooper, Heron, & Heward, 2007; Rooker, Deleon, Borrero, Frank-Crawford, & Roscoe, 2015).

Reversal design is useful when evaluating the effects of a single independent variable; however, if evaluating the effect of several independent variables, a multielement design can be more efficient. The multielement design incorporates multiple, relatively quick reversals, allowing the comparison of different independent variables with respect to their effects on a target behavior. For example, two experimental operations, A and B, might be rapidly alternated with a control (no-treatment) condition, such that all other factors (e.g., time of session, experimenter conducting sessions, setting) are counterbalanced to allow a direct comparison of the effectiveness of the two treatments. For example, the original Iwata et al. (1984/1994) FA used a multielement manipulation in which three different experimental conditions were rapidly alternated with a control condition until differential responding was observed, and the function of the target behavior was thus identified (Cooper, Heron, & Heward, 2007; Sidman, 1960). Although multielement manipulations can be useful to evaluate several independent variables with respect to a target behavior in a short period of time, they sometimes yield undifferentiated results, and alternative experimental designs are necessary.

In 1994, Iwata, Duncan, Zarcone, Lerman, and Shore, described a pairwise design that contained features of both multielement and reversal designs. During each phase, the test condition (B) was alternated with a control condition (A) in a multielement design and each test condition was evaluated sequentially using a reversal design. The purpose of the pairwise design is to minimize interaction effects (i.e., interference of multiple treatments), as well as decrease the number of reversals required to demonstrate a functional relation. In the Iwata et al. (1994) study, data from the multielement assessment were undifferentiated for two participants; however, after implementing a pairwise manipulation the FA indicated differentiated outcomes for both participants (Hanley et al., 2003).

Sequence of Functional Analysis Conditions

Despite multielement arrangements being reported as the most common experimental

design used for FAs, several potential limitations of the multielement design have been

discussed, including sequential confounding, carryover effects, and alternation effects (Beavers

et al, 2013; Barlow & Hayes, 1979). Sequential confounding (multiple treatment inference)

occurs when the order of conditions influences the extent to which the independent variables

affect the dependent variable. For example, in an ABAB reversal design, condition A is always

conducted prior to condition B, thus, any observed change in the dependent variable might be

due to the sequence in which the conditions were conducted and not solely to the independent

variable manipulation. That is, condition A could establish a motivating operation that might

evoke behavior during condition B independent of, or in concert with, the independent variable.

For example, if an alone condition precedes an attention condition, the withdrawal of attention

during the alone condition might make attention more valuable than it would otherwise be in the

attention condition (or in the natural environment). Moreover, carryover effects can occur when

one treatment influences another temporally-adjacent treatment because responding during one

condition continues in the next condition, especially when other aspects of the experimental

arrangement are similar (e.g., setting, experimenters).

However, randomizing the sequence of conditions being compared can, to some extent,

control for the effects of sequential confounding (Barlow & Hayes, 1979; Kazdin, 1982). For

example, Johnson and Bailey (1977) implemented a program designed to increase leisure activity

participation (e.g., painting, playing cards) for women diagnosed with disabilities. Two

interventions were compared. The first intervention included making materials (e.g., playing

cards, paint brushes) available, and the second intervention, in addition to making materials

available, allowed the women to earn rewards (e.g., cosmetics, record albums). The results indicated both interventions improved participation; however, the rewards intervention lead to greater changes. Additionally, Johnson and Bailey noted that the effect of the first intervention depended on whether it was presented first or second. If the materials intervention was implemented prior to the materials plus rewards intervention, it was more effective than if it was employed after the materials plus rewards intervention. Thus, a clear sequence effect was observed based on the order in which the interventions were implemented.

Furthermore, methods to minimize possible carryover effects include counterbalancing conditions, ensuring discriminability between different conditions (e.g., by only conducting one condition per session, correlate each condition with a room, color, etc.), and decreasing the speed at which conditions are alternated. Conners et al. (2000) conducted an FA to evaluate the extent to which discriminative stimuli facilitated differential responding for self-injurious behavior or aggression of eight adults diagnosed with disabilities. During phase 1, each FA condition was correlated with a specific therapist and room color. In phase 2, all FA conditions were conducted in the same room by the same therapist. Results indicated during phase 1, differentially high levels of responding were observed for all participants. However, in phase 2, immediate differentiated results were obtained for four participants; for three participants, differentiation was eventually observed; and, for one participant, no differentiation was observed. These data suggest that correlating different treatment sessions with different discriminative stimuli can enhance or facilitate differential responding.

Another potential limitation of multielement designs is alternation effects. Alternation effects refer to the effects of rapid alternation of multiple conditions on the dependent variable, regardless of condition order (Barlow & Hayes, 1979). Rapid alternation can decrease

discrimination between different conditions and yield undifferentiated results. One alternation

effect is the effect of sequence on behavior (i.e., sequence effects). For example, Hammond et

al. (2013) investigated the effects of fixed- versus random-condition sequencing in a

multielement FA. Both fixed- and random-sequence FAs were conducted with seven individuals

with developmental disabilities. In the fixed-sequence, conditions were conducted in a set order:

ignore, attention, play, and demand. In the random-sequence, condition order was conducted in

a semi-random order. Results from the study indicated that, for three of seven participants,

responding only emerged during the fixed-sequence condition, and for one participant,

responding emerged more quickly under the fixed-sequence condition. For the three remaining

participants, sequencing appeared to have no effect. These data indicate that fixed-sequences in

FAs might facilitate discrimination between conditions, and therefore might lead to quicker or

more differentiated responding than random-sequence FAs.

Methodological Modifications

Most published studies involving FA methods include the conditions described by the

seminal 1982/1994 Iwata et al. publication (i.e., attention, demand, alone, play; see Beavers et

al., 2013). However, literature suggests that modifications can be made to those conditions to

produce clearer results, for example, to accommodate different response topographies, or for

reasons involving participant safety.

Identifying idiosyncratic antecedent and consequent variables (e.g., variations in task

dimensions and types and quality of attention delivered) can sometimes facilitate the functional

analysis of behavior (e.g., Call, Wacker, Ringdahl, Cooper-Brown, & Boeiter, 2004; Richman &

Hagopian, 1999; Piazza et al., 1999; Mace & Lalli, 1991). It is not always prudent to assume

that the contingency that maintains behavior during analogue experimental conditions does so in

the natural environment. If FAs yield undifferentiated results, it is possible that the relevant

antecedents and consequences were not included and, thus, some researchers have suggested that

naturalistic observations can help identify those variables (Hanley et al., 2003; Mace & Lalli,

1991; Schlichenmeyer, Roscoe, Rooker, Wheeler, & Dube, 2013). For example, Mace and Lalli

(1991) conducted a descriptive analysis of bizarre vocalizations in a natural environment to

identify antecedents and consequences that were correlated with bizarre speech. Their analysis

suggested that bizarre speech occurred most frequently in demand and low-attention situations,

and also provided information regarding possible natural schedules of escape and attention,

which were then used to determine the schedules used during the experimental analyses.

Additionally, the authors suggested that the specific antecedents and consequences observed

during the analysis helped increase assessment precision and save time by decreasing the number

of necessary experimental conditions. However, after identifying the antecedent and consequent

variables maintaining the target behavior, further adjustments to the FA conditions might be

warranted to identify idiosyncratic variables.

Other experimental conditions, such as diverted attention and different types of attention

(e.g., reprimands, statements unrelated to the problem behavior), have been developed as

variations of the typical FA conditions with the purpose of simulating contingencies occurring in

the participants' natural environment (e.g., Mace, Page, Ivancic, & O'Brien, S, 1986; O'Reilly,

Lancioni, King, Lally, & Dhomhnaill, 2000; Fisher, Ninness, Piazza, & Owen-DeSchryver,

1996; Richman, & Hagopian, 1999). For example, Fahmie, Iwata, Harper, and Querim (2013)

conducted a study comparing a typical attention condition (Iwata et al., 1982/1994) to a diverted-

attention condition to determine whether problem behavior was more sensitive to one test

condition than the other. The diverted-attention condition differed from the typical attention

condition in that, rather than pretending to be busy reading or writing, the experimenter conversed with a confederate. The results indicated that for most participants the diverted-attention and typical attention condition evoked similar levels of the target behavior. However, for one participant, the target behavior emerged more quickly during the diverted attention condition, suggesting that when there are time constraints and a confederate is available, diverted attention can be an efficient alternative to a typical attention condition.

Furthermore, to determine possible idiosyncrasies in regards to attention, Fisher et al. (1996) assessed the effects of different contingent consequences in the form of reprimands or unrelated verbal statements on destructive behaviors observed during an FA. Initially, a standard FA was conducted and indicated the behavior was maintained by attention in the form of verbal reprimands (e.g., "Don't hit me."). A second analysis was conducted with two conditions, a verbal reprimands condition (e.g., "Don't hit me.") and an unrelated verbal statements condition (e.g., "It's nice weather today."). The results from the analysis indicated contingent verbal reprimands produced higher levels of problem behavior than contingent statements that were unrelated to the problem behavior. Even though both conditions provided attention contingent on the problem behavior, one form of attention evoked more problem behavior, although the overall interpretation of the two analyses was the same (i.e., the problem behavior was attention-maintained).

Some behavior topographies, such as elopement (i.e., leaving a designated area without permission), can be more challenging to assess than others, requiring modification to the standard FA conditions. Recording instances of elopement usually requires the participant to leave the designated session area multiple times and be retrieved in order for the participant to have multiple opportunities to respond. Piazza et al. (1997) conducted a modified version of the

FA procedures described by Iwata et al. (1982/1994) to identify the maintaining variables of elopement with three individuals. The conditions were modified to simulate the natural setting from which participants usually eloped. In addition to the typically programmed consequences, if elopement occurred, the participant was retrieved. However, the consequences delivered for elopement (i.e., retrieval of participant) introduced a potential confound (e.g., attention in the form of physical retrieval) that might have influenced the FA results.

To reduce the confounding effect of attention during retrieval, Neidert, Iwata, Dempsey, and Thomason-Sassi (2013) conducted a study using latency to elopement as the dependent measure. The assessment consisted of three experimental conditions (i.e., attention, demand, and ignore) and a control condition. Elopement was permitted during all conditions except the attention condition. The researchers conducted the sessions in this manner to prevent the confounding effect of contingent escape as a result of elopement. The data were undifferentiated across all test conditions and indicated multiple control for elopement for both participants. Nevertheless, treatments based on the multiple functions increased appropriate behavior and increased the latency to elopement for both participants.

Other behavior topographies that can require modifications to the standard FA conditions include the two most frequently studied problem behaviors: SIB and aggression (Hanley et al., 2003; Beavers et al., 2013). Because the purpose of most FAs is to evoke problem behavior, many studies have evaluated alternative ways to conduct test conditions to minimize safety concerns. To prevent excessive physical harm, researchers frequently use an ignore or no-interaction condition rather than an alone condition for participants whose problem behaviors include SIB. For example, Davis, Kahng, Schmidt, Bowman, and Boelter (2012) used a no-interaction, rather than an alone, condition to accommodate participants who engaged in severe

SIB. During the ignore conditions, an experimenter was present in the session area but no access to tangible items or attention was available. Because experimenters were present, they could block instances of SIB but still conduct an FA that could include an approximation of an automatic reinforcement test condition.

Another strategy to accommodate safety issues consists of using precursor behaviors (i.e., behaviors that reliably precede the occurrence of problem behavior) to infer the function of the target behavior. In 2002, Smith and Churchill assessed the effectiveness of using identified precursor behaviors as target behaviors during an FA, and the results were compared to a standard FA of the target behaviors. The precursor behaviors were operationally defined for all participants and were identified by reports from caregivers and direct observations. Their results suggested that the precursor FA identified the same function as the standard FA for all participants, and, additionally, the occurrence of target behaviors was lower during the precursor FAs.

Behavior Topography and Measurement

FAs involve direct observation of behavior and recording methods appropriate to the target behavior under investigation. In a review conducted by Beavers et al. (2013), the most commonly used methods reported were frequency or rate, while only 15 of 158 studies reviewed (9.3%) reported using duration or latency as a response measure. Other measures noted in the review were partial-interval recording, whole-interval recording, and momentary time-sampling.

However, these standard measurements sometimes require methodological adjustments because of the target behavior in question. For example, when measuring frequency, the target behavior is allowed to occur multiple times. However, when the target behavior is, for example, aggression or SIB, repeated occurrence can pose a risk to participants or experimenters. Thus,

for some behaviors, latency might be a more appropriate response measure so that the session is terminated after the first occurrence of the target behavior. Thomason-Sassi, Iwata, Neidert, and Roscoe (2011) conducted three experiments comparing response rate and latency during functional analyses of problem behaviors. In the third experiment, the results from the latency FA (during which the sessions were terminated after the first occurrence of the target behavior) were compared to a standard FA. For 9 of 10 participants, the latency FA results corresponded with the standard FA results, indicating that latency can be a useful measure when allowing repeated occurrences of the target behavior is impractical or dangerous.

In the FA literature, some of the most commonly assessed behavior topographies are self-injurious behavior (SIB), aggression, and vocalizations (Beavers et al., 2013; Hanley et al., 2003). However, several studies have also used FA methods to identify the function of appropriate behaviors (Hustyi, Normand, Larson, and Morley, 2012; Larson, Normand, Morley, and Miller, 2013/2014; Normand, Machado, Hustyi, and Morley, 2011; Zerger, Normand, Boga, & Patel, 2016). For example, Normand, Machado, Hustyi, and Morley (2011) taught typically developing infants to make manual signs (gestures) that were reinforced with food. After sign training, they conducted an FA to assess the function of those manual signs. The results indicated that the FA identified specific condition(s) that evoked signing, suggesting that the FA methodology might be a useful tool for studying verbal behavior. More recently the FA methodology has also been utilized to assess methods to increase physical activity in young children (Hustyi, Normand, Larson, & Morley, 2012; Larson, Normand, Morley, & Hustyi, 2014; Larson, Normand, Morley, & Miller, 2013/2014; Zerger, Normand, Boga, & Patel, 2016). However, further research on the use of the FA methodology to identify the maintaining variables of appropriate behaviors is warranted.

Functional Assessments of Physical Activity

Brown et al. (2009) conducted a descriptive assessment to identify environmental

variables that were predictors of MVPA by analyzing intervals in which participants engaged in

MVPA from a large sample of naturalistic direct observations. MVPA was measured using the

Observational System for Recording Physical Activity in Children-Preschool Version (OSRAC-

P; Brown et al., 2006). Using the OSRAC-P, the level of activity was recorded as one of five

intensity levels: (1) stationary or motionless activities (e.g., sleeping, lying completely still); (2)

stationary with limb or trunk movements (e.g., standing and swinging arms); (3) slow, easy

movements (e.g., walking); (4) moderate movements, (e.g. climbing, walking uphill); (5) fast

movements (e.g., running). Activity levels 4 and 5 constituted MVPA. Additionally, the

immediate social (i.e., initiators of activities, group compositions, and prompts for physical

activity) and nonsocial (i.e., primary locations, indoor activity contexts, and outdoor activity

contexts) environmental circumstances occurring with MVPA were also recorded. The results

indicated three outdoor contexts correlated with MPVA: outdoors toys, open space, and fixed

equipment. These results are important in that they allowed researchers to both record levels of

physical activity and identify specific settings in which children seemed more likely to engage in

MVPA than others. This could, for example, help increase physical activity in school settings

where limited time is provided for physical activity and children could be provided access to

specific outdoor contexts correlated with higher levels of MVPA. Additionally, the results also

provided key information that informed further research.

More recently, Howie et al. (2013) described the physical activity of very active

preschoolers in indoor and outdoor settings. During direct observations, the researchers used

accelerometers and the OSRAC-P to identify high- and low-active children to compare the

different types and intensity of activities in which they engaged. Results indicated that when playing outside, high-active children played more on the fixed equipment than they did in open space, and engaged in higher-intensity activities than low-active children in indoor settings. However, activity intensity did not differ between high- and low-active children in outdoor settings.

Descriptive assessments, such as those reported by Brown et al. (2009) and Howie et al. (2013), can provide important information and avenues for future research; however, a primary disadvantage for both is that their results are only correlational. That is, functional relations between MVPA and certain environmental can only be inferred, not empirically demonstrated. Because of this, several recent studies have used FA methods to identify environmental variables that influence physical activity.

Hustyi, Normand, Larson, and Morley (2012) used the FA methodology to assess the influence of activity context on physical activity levels in typically developing preschool children. Participants were systematically exposed to 4 different outdoor activity contexts, similar to those Brown and colleagues (2009) identified as correlates of MVPA. Prior to the assessment, a 30-min naturalistic observation was conducted in which all outdoor activity contexts were available to all participants simultaneously. Two 5-min samples were then used as baseline levels of MVPA for each participant. Activity contexts were alternated in a multielement design and included fixed-equipment, outdoor-toy, open-space, and control conditions. Prior to all experimental conditions, the experimenter prompted participants to play in specific outdoor contexts, then stepped away from the session area and started the session. During experimental conditions, no consequences were provided for any response, and participants were alone to control for social variables (e.g., peer activity, adult prompts, praise)

that might influence levels of physical activity. However, if participants tried to leave the session area, they were prompted to return. During fixed-equipment conditions, a jungle gym was available for participants to play in, and during outdoor toys conditions, participants received access to a variety of outdoor toys (e.g., Frisbees, soft balls, jump ropes) and were prompted to play with the toys. During open space conditions participants did not receive access to any materials (e.g., outdoor toys, fixed equipment) but were guided to an open grassy area and instructed to play in the grass. During control conditions, participants were guided to a table on the playground and were prompted to play with table activities (e.g., coloring books, crayons, figurines). Results indicated differentiation between levels of MVPA and different outdoor activity contexts. For all participants, MVPA occurred during all experimental conditions but, overall, the fixed equipment evoked the highest levels of MVPA. However, one limitation of the study was that all participants were assessed while playing alone, and thus the results might not necessarily generalize to circumstances in which children are playing with other children.

In an extension of Hustyi et al. (2012), Larson, Normand, Morley, and Hustyi (2014) examined participants in different group compositions across various activity contexts. The methodology was similar to that described by Hustyi et al. (2012), but participants were exposed to the activity contexts with differing numbers of peers present. Initially, participants were exposed to the contexts alone, then with one peer present, and then with two or three peers present. The results indicated that for 6 of 8 participants, fixed equipment evoked the highest levels of MVPA, and for 2 participants fixed-equipment and open-space conditions evoked similar levels of MVPA. For all participants, having one or more peers present during sessions was associated with higher levels of MVPA than sessions in which participants were alone.

Larson, Normand, Morley, and Miller (2013) further extended the work of Hustyi et al. (2012) and Larson et al. (2013) by conducting a consequence-based FA similar to the experimental manipulations described by Iwata et al. (1982/1994). Participants were systematically exposed to four experimental conditions and one control condition. The experimental conditions evaluated were alone, attention contingent on MVPA, adult interaction contingent on MVPA, and escape from task demands contingent on MVPA. Prior to the assessment, several baseline sessions were conducted to determine the level of MVPA prior to exposing participants to experimental conditions. Baseline sessions were conducted on the playground during normal playtime when other children were present, however during all other session no peers were present. During all conditions, participants had access to all outdoor contexts (i.e., outdoor toys, fixed equipment, open space), and at the start of each condition the experimenter delivered a statement describing the contingencies in place. For example, at the start of attention conditions the experimenter would state, "If you run, jump, or climb, I will talk to you. But if you don't, I will have to do some work." During alone conditions, participants were guided to the session area and the experimenter stated, "I have to go inside and do some work. Play out here for a little bit," and went inside the building. During attention conditions, contingent on MVPA, the experimenter made eye contact with the participant and delivered attention in the form of brief specific praise (e.g., "I like how fast you are running!"). During interaction conditions, contingent on MVPA the experimenter delivered attention in the form of brief specific praise, and engaged with the participant in the ongoing activity as long as the participant was engaged in MVPA. During escape conditions the participant was guided to a table on the playground and the experimenter stated, "If you don't want to do work or if you get tired of working, you can go run, jump, or climb." The experimenter delivered instructions

every 10-s using a three-step prompting sequence (i.e., verbal prompt, model prompt, physical prompt) for the participant to complete a worksheet. Contingent on MVPA the experimenter terminated instructions and turned away from the participant for 30-s. Results indicated, for all participants, levels of MVPA were highest during the attention and interactive-play conditions, and infrequent or no occurrences of MVPA were observed in the escape, alone, and control conditions.

However, one limitation of the Larson et al. (2013) study was that attention was provided during both attention and interactive-play conditions, such that the independent effects of attention and interactive play could not be determined. Thus, in a subsequent study, Larson, Normand, Morley, and Miller (2014) refined the methodology of Larson et al. (2013). First, they included a fixed-time (FT) 30-s schedule of attention during interactive play conditions. Second, they conducted a brief treatment evaluation to determine if, when the condition resulting in the highest levels of MVPA was used as an intervention, the levels of MVPA would persist at levels observed in the FA. Third, to increase ecological validity of the antecedent variables during the escape condition, changes were made to task demands used in the escape condition. All other procedures were similar to those reported by Larson et al. (2013). The highest levels of MVPA occurred in the interactive play and attention conditions, and low levels of MPVA occurred during the escape, alone, and control conditions during the FA. Moreover, during a brief treatment evaluation, participants were exposed to the condition that evoked the highest levels of MVPA across multiple sessions. During the treatment evaluation, levels of MPVA were variable but remained higher than baseline levels; however, for two participants, levels of MVPA were similar to those observed during the other FA conditions. Additionally, for at least one participant, a decreasing trend was suggested in the treatment analysis. Due to time constraints,

a limited number of sessions were conducted, and thus, it is difficult to determine whether high levels of MVPA would have persisted if more sessions were conducted.

Most recently, Zerger, Normand, Boga, and Patel (2016) replicated and extended the Larson et al. (2014) methodology by comparing the condition that engendered the highest level of MVPA during the FA (i.e., contingent reinforcement condition) to a condition in which reinforcement was delivered according to an FT schedule. However, the escape condition was not conducted because of low levels of MVPA for all participants during previous studies (Larson et al., 2013, 2014). The purpose of the comparison was to conduct an intervention analysis to determine if the FA contingency was the maintaining variable of MVPA, or if other variables were at play. During phase 1, an FA was conducted, replicating the methodology described by Larson et al. (2014). Additionally, during interactive play conditions, to control for attention delivered during physical engagement, brief 5-s verbal attention was delivered on an FT 30-s schedule. During phase 2, the intervention analysis was conducted in a reversal design, and participants were exposed to a contingent reinforcement (CR) condition (i.e., the condition that evoked the highest levels of MVPA during the FA), as well as an FT reinforcement condition. The FT schedule of attention was based on the mean interresponse time (IRT) between instances of MVPA during the first few CR conditions, and reinforcement was delivered for approximately 5 s regardless of MVPA occurrence. The results from the study supported previous results reported by Larson et al. (2013, 2014) and indicated that MVPA occurred most often in the attention and interactive play conditions for most participants. Additionally, for three of five participants, CR conditions evoked higher levels of MVPA then the FT conditions. However, for two participants, high levels of MVPA did not persist in the CR conditions or FT conditions during phase 2. These results are consistent with the results reported by Larson et al. (2013) and

provide valuable information about the use of the FA methodology to identify variables that produce high levels of MVPA, and possible implications for function-based interventions. However, the same limitation was identified as in Larson et al. (2014), and an overall decrease in levels of MVPA was observed within and across different intervention conditions. This decrease in MVPA can hinder further improvements of physical activity intervention analyses, and is important to investigate to better establish and maintain high levels of MVPA in children.

Purpose

Previous research has identified the attention and interactive play conditions as the most effective FA test conditions for evoking and maintaining MVPA with young children. However, that research (e.g., Larson et al., 2014; Zerger et al., 2016) suggests that MVPA sometimes decreases over time when the attention or interactive play conditions are implemented repeatedly and independent of the other FA conditions. It is possible that the attention and interactive play conditions are more effective when alternated with other FA conditions, as compared to when they are repeatedly presented independent of other conditions. Therefore, the purpose of the proposed study is threefold: (1) to partially replicate the Zerger et al. (2016) methodology assessing the influence of social consequences on MVPA, (2) to assess the effects of alternating the FA test conditions and repeated presentation of a single condition, and (3) to evaluate the effectiveness of variable schedules of reinforcement during intervention conditions.

General Method

Participants

Participants will include 4-6 preschool-aged children with no reported developmental disabilities or other health conditions. Each participant's legal guardian will read and sign an informed consent form explaining the purpose and procedures of the study. Each legal guardian

will receive a $20 gift card following completion of the study; however, if participants are not able to complete the study, the legal guardian will receive a $5 gift card. The local institutional review board will review and approve all aspects of the study prior to participant recruitment.

Setting and Materials

Sessions will be conducted at a local preschool or daycare where participants have access to a fixed play structure (i.e., a jungle gym) and an open grassy area. Sessions will be conducted 1-5 days per week during times that the playground is not being used by other children. During all sessions, participants will have access to all areas of the playground, and outdoor toys (e.g., balls, hula hoops, Frisbees) will also be provided. Other materials will include a stopwatch to record the session length, and a form to track sessions and participant numbers. All sessions will be recorded using a video camera.

Response Definition and Measurement

The primary dependent variable will be MVPA, scored as a dichotomous variable based on the OSRAC-P activity codes (see Table 1). Following from previous research (e.g., Brown, et al., 2009; Hustyi et al., 2012; Larson et al., 2013) and the CDC's (2011) recommendation for children to engage in moderate and vigorous activities, MVPA will be defined as OSRAC-P activity codes 4 (i.e., moderate movements) and 5 (i.e., fast movements). Activity codes will be scored using a 1-s continuous partial-interval procedure in which MVPA will be scored as "on" when codes 4 or 5 are observed, and will be scored as "off" when codes 1, 2, or 3 are observed. Activity codes will be scored on a desktop computer from video records using InstantData (Samaha, 2002).

Reliability and Integrity

All sessions will be video recorded and two independent observers will collect data from the video records. Interobserver agreement (IOA) will be calculated by dividing the number of agreements of the 1-s continuous partial-interval system by the number of agreements plus disagreements and multiplying by 100 to yield a percentage. An agreement will be defined as both observers independently recording the occurrence or nonoccurrence of MVPA during the same 1-s interval. IOA will be calculated for at least 33% of sessions.

Additionally, observers will independently record the integrity of reinforcer delivery during all experimental sessions. The reinforcer delivery will be scored as "Yes" if the experimenter delivers the appropriate reinforcement within 2 s of the onset of MVPA, or scored as "No" if the experimenter does not deliver the appropriate reinforcement within 2 s of the onset of MVPA.

Observer training

Observers will be trained undergraduate and graduate research assistants. Initially, the observers will read relevant research articles (i.e., Brown, et al., 2009; Hustyi, Normand, Larson, & Morley, 2012; Larson, Normand, Morley, & Miller, 2013; Larson, Normand, Morley, & Hustyi, 2014; Zerger, Normand, Boga, & Patel, 2016) to review response definitions and data collection procedures (e.g., the OSRAC-P activity codes). Next, observers will be tested on their understanding of the response definitions and data collection procedures via a short multiple-choice quiz. Observers will be required to earn a score of 80% or higher; observers scoring 79% or below will be required to review the research articles and response definitions and retake the quiz until the criterion is met. Lastly, after scoring 80% or higher on the quiz, observers will begin training on recording occurrence of physical activity using videos by practicing data

collection using the InstantData software (Samaha, 2002). All videos used for training will have master data records, created by two trained observers, to which trainee performances will be compared. First, the physical activity recording training will include four videos with staged physical activity. Observers will collect data on occurrences of MVPA for all four videos, and will be required to reach 90% agreement with the master data records for each video; observers scoring 89% or below on any video will be required to repeat their data collection for that video until the criterion is met. Second, the physical activity recording training will include two sets of four videos with actual participants from previous studies on physical activity. Similar to the first step of data collection training, observers will be provided with four videos and will collect data on occurrences of MVPA; to meet criterion observers are required to reach 90% agreement with the master data records for each video. Third, after reaching criterion for all four videos, the last four videos will be provided to observers in sets of two. To meet criterion for the first set of videos, observers will be required to reach 90% agreement with the master data records for each video prior to gaining access to the last set of videos. After observers complete both sets of videos and reach a minimum of 90% agreement with the master data records, the physical activity recording training will be completed.

Procedure

All sessions will be 5 min in length, and 1 to 4 sessions will be conducted per day. During all sessions, participants will have access to all areas of the playground (i.e., fixed play structure and open grassy area) and a variety of toys and activities (e.g., jump ropes, bouncy balls, hula hoops) will be available to the participant.

Experiment 1

The purpose of Experiment 1 is to identify the antecedent and consequent events that occasion the highest level of MVPA, and to evaluate whether MVPA will persist when participants are repeatedly exposed to the same condition.

Procedure

Baseline. The purpose of this condition is to measure the amount of MVPA exhibited prior to any experimental manipulations. This condition will be conducted in the same manner as the alone condition during the FA (described below), and the two conditions will be compared across phases. Sessions will be conducted until a stable pattern of MVPA is observed across 3 consecutive sessions. The experimenter will guide the participant to the session area and state, "I am going inside to talk to your teacher. You can play out here until I come back." The experimenter will then leave the session area and remain out of sight during the session. During this condition, no attention or consequences will be delivered contingent on MVPA.

Functional Analysis. The FA will be a partial replication of Zerger et al. (2016); however, the alone condition will serve as a control condition from which to compare levels of MVPA across experimental conditions. The FA will be arranged according to a multielement experimental design and sessions will be conducted until data are differentiated, or until a total of 4 to 5 sessions have been conducted for each FA condition.

Attention. The purpose of this condition is to identify whether social positive reinforcement in the form of adult attention can produce higher levels of MVPA compared to alone conditions, when social reinforcement is not available. The experimenter will guide the participant to the session area and state, "If you run, jump, or climb, I will talk to you. But if you

don't, I'll have to do some work." Contingent on MVPA, the experimenter will deliver

approximately 5 s of attention specific to the participant's ongoing activity, while the participant

continues to engage in MVPA (e.g., "Good job running!"). After the 5 s of attention, if the

participant continues engaging in MVPA, the experimenter will continue to deliver attention

according to a FT 5-s schedule for as long as MVPA persists. When the participant is not

engaging in MVPA, the experimenter will appear busy and deliver no verbal (e.g., praise) or

nonverbal (e.g., eye contact, shoulder touch) attention.

     Interactive Play. The purpose of this condition is to determine whether social positive

reinforcement in the form of physical interaction produces higher levels of MVPA compared to

baseline. During the interactive play condition, the experimenter will guide the participant to the

session area and state, "If you run, jump, or climb, I will play with you. But if you don't, I'll

have to do some work." Interactive play will be delivered according to the same schedule

described during the attention condition. For example, if the participant begins running on the

playground, the experimenter will run with the participant for 5 s while delivering praise specific

to the ongoing activity. Additionally, to control for verbal attention delivered during the

interactive play, brief statements specific to the experimenter's current behavior will be delivered

(e.g., "I am running with you!") according to an FT 30-s schedule. When the participant is not

engaging in MVPA, the experimenter will appear busy and deliver no verbal (e.g., praise) or

nonverbal attention (e.g., eye contact, shoulder touch), or play.

     Alone. The purpose of this condition is to identify whether MVPA occurs in the absence

of social contingencies. This condition will serve as a control condition to compare conditions in

which social reinforcement is available (i.e., attention condition, interactive play condition) and

when social reinforcement is not available (i.e., alone condition). The experimenter will guide

the participant to the session area and state, "I am going inside to talk to your teacher. You can play out here until I come back." The experimenter will then leave the session area and remain out of sight during the session. The cameraperson will remain outside with the participant to provide supervision and record the session. No programmed consequences will be delivered contingent on MVPA.

Intervention. The purpose of this phase will be to evaluate if levels of MVPA maintain elevated when participants are repeatedly exposed to the same condition, as would be the case during an intervention based on the results of the FA. During this phase, participant will be exposed to the FA condition that evoked the highest level of MVPA until a stable level of MVPA is observed across 3 consecutive sessions, or until a decreasing trend is observed.

Experiment 2

Experiment 2 will include participants from Experiment 1 for which a decreasing trend is observed during the intervention phase of Experiment 1. The purpose of Experiment 2 is to evaluate if the levels of MVPA during the initial FA can be replicated and a second FA will be conducted. The second FA will be conducted in a manner identical to the FA conducted in Experiment 1.

Experiment 3

Experiment 3 will be conducted according to a multiple-baseline across participants design, and will include participants for which the MVPA persisted during intervention in Experiment 1. The purpose of Experiment 3 is to evaluate whether MVPA will persist when a variable reinforcement schedule is implemented. If MVPA does not persist, a second intervention phase identical to that in Experiment 1 will be introduced.

Procedure

     Momentary Time Sampling. In the momentary time-sampling procedure, data will be collected at the end of a predetermined time period (Cooper, Heron, & Heward, 2007), as compared to the intervention phase of Experiment 1, where participants will be monitored continuously. During Experiment 3, the momentary time-sampling schedule will be based on the mean IRT between recorded instances of MVPA in the intervention phase of Experiment 1. For example, if the mean IRT for a participant is 20 s, the experimenter will conduct momentary time sampling at the end of each 20 s interval. After 20 s elapses, the experimenter will observe the participant for 5 s and, contingent on MVPA, deliver consequences in the same manner as the intervention phase of Experiment 1. Immediately following each 5-s observation interval, the next 20 s interval will begin. No programmed consequences will be delivered contingent on MVPA that occurs outside of the 5-s observation interval.

     Intervention. The intervention phase will include participants for which a decreasing trend in levels of MVPA is observed during the momentary time-sampling phase. The intervention phase will be identical to the intervention phase conducted in Experiment 1.

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Hypothetical Results

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     Data for the proposed study will be graphed and visually analyzed. Graphs will depict percentage of intervals of MVPA for each session during all phases of the study. Figure 1 depicts the hypothetical results for one participant during Experiments 1 and 2. The data indicate that during the FA phase of Experiment 1, levels of MVPA were elevated during the interactive play condition and during the intervention phase, when the participant was exposed to the same condition repeatedly, levels of MVPA decreased. However, the data indicate that the levels of

MVPA evoked during Experiment 1 were replicated during Experiment 2, when the participant was again exposed to the multielement method of the FA.

Figure 2 depicts the hypothetical results for one participant during Experiments 1 and 3. The data indicate during the FA phase of Experiment 1, levels of MVPA were elevated during the attention condition and during the intervention phase, when the participant was exposed to the same condition repeatedly, levels of MVPA maintained. However, the data indicate that during Experiment 3, when the participant was exposed to the momentary time sampling phase, levels of MVPA decreased. Lastly, the data indicate that during Experiment 3, when the participant was again exposed to the intervention phase, the levels of MVPA during Experiment 1 were replicated.

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