Evaluating the Effects of Peer Competition on Physical Activity During School Recess

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Evaluating the Effects of Peer Competition on Physical Activity During School Recess

by

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A dissertation submitted in partial fulfillment of the requirements for the degree of Doctor of Philosophy in Applied Behavior Analysis
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# Table of Contents

List of Figures ................................................................................................................... iii

Abstract ............................................................................................................................... iv

Overweight and Obesity ................................................................................................. 1

Physical Activity .............................................................................................................. 3
  A Note to Reader ............................................................................................................. 3
  Physical Activity Measurement ....................................................................................... 3
  Self-Report ....................................................................................................................... 3
  Mechanical Measures ..................................................................................................... 4
  Direct Observation .......................................................................................................... 5
  Functional Assessment .................................................................................................. 7

Physical Activity Interventions ....................................................................................... 10
  Classroom-Based Interventions ...................................................................................... 10
  Individualized Interventions ......................................................................................... 12
    Home-based Interventions ............................................................................................ 12
    School-based Interventions ......................................................................................... 14
    School-Wide Interventions ......................................................................................... 15

Purpose .............................................................................................................................. 19

Method ............................................................................................................................... 20
  Participants and Setting ................................................................................................. 20
  Materials ......................................................................................................................... 20
  Response Measurement and Reliability ........................................................................ 21
  Procedure ......................................................................................................................... 21
    Baseline .......................................................................................................................... 22
    Intervention ................................................................................................................... 23
      Intervention at Recess ............................................................................................... 23
      Physical Education (PE) ........................................................................................... 24

Results ............................................................................................................................... 26

Discussion .......................................................................................................................... 29
References.................................................................................................................................34

Appendices...................................................................................................................................40
  Appendix A: Figures..................................................................................................................41
  Appendix B: Pedometer (Model: Yamax DigiwalkerTM CW-200) .........................................50
  Appendix C: Participant Data Sheet .........................................................................................51
  Appendix D: Graphical Display of Feedback ..........................................................................52
  Appendix E: Expedited Approval for Initial Review (2014) ..................................................53
  Appendix F: Permission for Previously Published Materials .................................................54
List of Figures

Figure 1: Mean steps per min across baseline (BL) and intervention phases for the class ........41
Figure 2: Mean steps per min during recess sessions for team 1 ........................................42
Figure 3: Mean steps per min during recess sessions for team 2 ........................................43
Figure 4: Mean steps per min during recess sessions for team 3 ........................................44
Figure 5: Mean steps per min during recess sessions for team 4 ........................................45
Figure 6: Mean steps per min during recess sessions for team 5 ........................................46
Figure 7: Mean steps per min during recess sessions for team 6 ........................................47
Figure 8: Mean steps per min during recess sessions for team 7 ........................................48
Figure 9: Mean steps per min during recess sessions for team 8 ........................................49
Abstract

With an increase in childhood obesity, engagement in regular physical activity is an important health-related behavior. In addition to being overweight or obese, a lack of physical activity can lead to other serious health risks. With children spending a majority of their weekdays at school, this environment should be used to promote physical activity. The purpose of the current study was to evaluate the effects of peer competition and feedback on children’s step counts. During baseline, participants wore a sealed pedometer during recess and physical education (PE). During intervention, participants with higher step counts were paired with participants with lower step counts. Teams were encouraged to compete for the highest step count each day, and feedback on their performance was provided during each recess session. Results showed a large mean increase in step count from baseline to intervention. These results suggest that children’s steps can be increased with a simple and cost-effective intervention during times of the day already allotted for physical activity.
Overweight and Obesity

In the United States (U.S.), more than a third of children and adolescents are considered overweight or obese (Centers for Disease Control and Prevention [CDC], 2015a). Due to the increasing prevalence of childhood obesity, incorporation of regular physical activity into the lives of youths is exceedingly important. Physical activity can be defined as any bodily movement produced by skeletal muscles that requires energy expenditure (World Health Organization [WHO], 2015a). In general, activities that are considered to be sufficient forms of physical activity include aerobics, muscle strengthening, play, games, transportation, chores, recreation, physical education, and planned exercise (CDC, 2015b; WHO, 2015b). Moreover, the CDC recommends that children engage in at least 60 min of moderate-to-vigorous physical activity (MVPA) per day. Activities and movements that constitute MVPA include, but are not limited to, brisk walking, running, jumping, and climbing.

Engagement in regular physical activity is important for several reasons. Benefits include the building and maintenance of healthy bones and muscles, and reducing the risk of obesity and other chronic diseases (CDC, 2015b). A lack of physical activity can lead to immediate and long-term negative health outcomes, including diabetes, cardiovascular disease, and cancer (CDC, 2015b). Therefore, it is important that individuals engage in the appropriate amounts of physical activity to help mitigate these potential risks, preferably beginning in childhood. Although this information indicates that engaging in 60 min of MVPA per day is an important health related behavior, many youths are not meeting this recommendation (CDC, 2015c).
With children spending a substantial portion of their day at school, efforts to promote physical activity in youths should take place during the school day. Schools have direct contact with 95% of the nation’s youth, ranging from 3- to 17-years of age. Therefore, schools have a central role in promoting physical activity and behaviors that align with a healthy lifestyle (CDC, 2020). Although every state in the U.S. has some physical education requirements for students, most schools do not enforce these requirements (Levi et al., 2014). Of the 23% of school districts throughout the U.S. that require schools to provide frequent physical activity breaks throughout the day, only 24.6% of them actually meet this requirement (CDC, 2012). Without allotted times for physical activity at school, children may not achieve the recommended level of activity over the course of their day. Therefore, there is a need for interventions that could be easily conducted during times of the day when there are opportunities for children to engage in physical activity.
Physical Activity

A Note to Reader

Portions of this introduction, method, and discussion sections are included in previously published materials.

Physical Activity Measurement

Physical activity can be measured using a variety of methods. Historically, indirect measures have been among the most commonly used and include self or proxy-report strategies such as interviews, questionnaires, and diaries (Sirard & Pate, 2001). More direct and objective measures, such as mechanical devices (e.g., heart rate monitors, pedometers, and accelerometers), direct observation methods also can be used (Sirard & Pate, 2001). More recently, functional assessment methods have been used to identify the environmental variables that may contribute to increased levels of activity (Hustyi et al. 2012). Each of these types of measures is briefly described below.

Self-Report

Self- or proxy-report instruments are among the most common ways to measure physical activity and include methods such as questionnaires, diaries, surveys, and interviews (Prince et al., 2008). These methods are easy and convenient ways to collect data and do not require much response effort from the informant. However, self- and proxy-reports are subjective and often produce unreliable data (Sirard & Pate, 2001). Both adults and children tend to misreport even recent events, making it difficult to obtain accurate information about their physical activity.
(Sirard & Pate, 2001). Klesges et al. (1990) assessed the reliability of self-report with adults, and the results suggested that, overall, adults tended to overestimate or underestimate activity levels, yielding inaccurate reports. To date, few studies have evaluated the relationships between observed physical activity and self-report measures with children. However, the lack of correspondence between adults’ self-report and physical activity suggests that self-reports from children would also be of questionable validity. Moreover, research has demonstrated that children’s self-reports of their own behavior can be unreliable, although the research has not necessarily focused on physical activity. For example, in a study assessing the accuracy with which young boys reported their own cleaning behavior in a group home, Fixsen et al. (1972) measured the reliability between an adult and peer observer’s observations and participants’ self-report of room cleaning. Results of the reliability assessment showed that the participants were not reliable in their own self-report, with a small set of items actually cleaned. The findings of Fixsen et al. (1972) lend support to the idea that, although self-reports from children may provide preliminary information on physical activity levels (Prince et al., 2008), they are likely to be inaccurate and unreliable.

**Mechanical Measures**

Mechanical devices provide a relatively objective way of measuring physical activity. For example, heart rate monitors are used to assess activity-related energy expenditure (EE), which is estimated based on the assumption of a linear relationship between heart rate and oxygen consumption (Eston et al., 1998). Although heart rate monitors are based on activity-related EE, they do not provide information about the specific activities related to the EE. Additionally, heart rate can be influenced by variables other than physical activity, including stress, and are
relatively insensitive, in that heart rate tends to increase at the start of exercise and plateaus to some extent thereafter (Eston et al., 1998).

Pedometers are small mechanical devices that can be worn at an individual’s hip and quantify physical activity in terms of cumulative step counts (Oliver et al., 2007). Accelerometers are similar to pedometers, but have an advantage in that they also record information on physical activity intensity. However, these devices cannot measure or accurately estimate EE across many types of activities (e.g., upper-body movement, load carriage, or changes in surfaces or terrain; Oliver et al. 2007), which is important when seeking activities that constitute MVPA. Additionally, Bassett et al. (2000) found that accelerometers overestimate the EE of walking and underestimate the EE of many other activities when used in free-living conditions. Most importantly, like heart-rate monitors, pedometers and accelerometers do not provide information about specific activity context or other environmental events during periods of physical activity, which are important pieces of information when attempting to identify events that might be correlated with higher levels of physical activity.

**Direct Observation**

Because of the limitations inherent to mechanical devices, some consider direct observation to be the gold standard of physical activity measures (Sirard & Pate, 2001). Direct observation allows researchers to record the frequency, duration, topography, and estimated intensity of physical activity. Additionally, direct observation permits the observer to record the occurrence of various environmental (including social) variables that might be functionally related to physical activity. For example, Brown et al. (2006) developed the Observational System for Recording Physical Activity in Children-Preschool version (OSRAC-P) as a way to assess physical activity levels in children in a preschool setting. The OSRAC-P uses a 5-s
observe, 25-s record, discontinuous-interval recording method. A 5-point activity rating scale
defines the different intensity of activities to be recorded and categorizes them as follows: (1)
stationary or motionless; (2) stationary with limb or trunk movements; (3) slow, easy
movements; (4) moderate movements; and (5) fast movements. Brown et al. observed
participants for 5-s and recorded the highest activity level observed. If participants engaged in
levels 4 or 5, they were considered to be engaging in MVPA. Potentially relevant environmental
variables (e.g., activity type, group composition, prompts, activity initiator, and activity context)
were scored during the 25-s record period.

Direct observation systems such as the OSRAC-P have proven to be reliable systems for
assessing and measuring physical activity behavior; however, the validity of such systems is not
as well established. In a study evaluating the concurrent validity of the OSRAC, Larson et al.
(2011) found that the activity codes in the OSRAC accurately depicted activity level in children
when compared with pedometer and heart rate monitors. Additionally, the OSRAC allows for the
recording of other potentially relevant variables, such as activity type, activity context, group
composition, and activity engagement. Despite the benefits of direct observation systems such as
the OSRAC, descriptive assessments do not involve the manipulation of environmental variables
and, therefore, cannot actually determine relevant functional relations. For example, Morley et
al. (2012, May) conducted a study comparing the results of descriptive analyses and functional
analyses of physical activity levels and environmental contexts in preschool children. Although
the results of both the descriptive and functional analyses yielded similar outcomes, with respect
to the environmental context in which MVPA occurred, the assessments failed to yield similar
outcomes for the identification of the environmental contexts related to MVPA. Overall results
indicated that the descriptive assessment could not be used to determine functional relationships
between environmental variables and MVPA. Therefore, a functional analysis is required to accurately quantify physical activity and related events when developing interventions to increase physical activity.

**Functional Assessment**

Functional assessments are used to identify the environmental variables that maintain a problem behavior exhibited by an individual. More recently, research has also used them to identify the function of desirable behaviors and to then develop an intervention to increase some dimension of that behavior (Schieltz et al. 2010; Hustyi et al. 2012; Larson et al. 2013; Zerger et al. 2016).

With respect to physical activity, Hustyi et al. (2012) reported a methodology for identifying the effects of outdoor environmental contexts on the MVPA of young preschool-aged children. Participants were exposed to several outdoor activity contexts and no programmed consequences were delivered contingent upon MVPA. Outdoor activity contexts included open space, outdoor toys, fixed-equipment, and play conditions in which participants were instructed to play in a specific area and were confined to that area throughout the session. Using the OSRAC-P coding system, data were collected on MVPA. Results indicated that participants engaged in the highest levels of MVPA when they were in the fixed-equipment context.

Larson et al. (2013) used a functional analysis to assess the MVPA of young children, manipulating both antecedent and consequent events to determine the social variables that were functionally related to MVPA. The purpose of the study was to identify whether certain conditions could be arranged to identify possible contingencies maintaining MVPA, rather than to identify already existing contingencies maintaining MVPA. The experimental conditions consisted of attention, interactive play, demand, alone, and a play condition, which served as the
control condition. During the attention condition, the experimenter delivered brief attention to the participant when he or she engaged in MVPA. During the interactive play condition, the experimenter interacted in the ongoing activity with the child contingent on MVPA for as long as he or she engaged in MVPA. During the demand condition, the experimenter delivered demands to complete clean up tasks on the playground. Contingent on MVPA, the experimenter terminated demands and allowed the participant to engage in MVPA for 30 s. During the alone condition, the participant was alone on the playground and no programmed consequences were delivered contingent on MVPA. The play condition served as the control condition in which the participant engaged in sedentary activities, or activities that were not thought to evoke MVPA, and no programmed consequences were delivered contingent on MPVA.

The results reported by Larson et al. (2013) indicated that levels of MVPA were highest in the interactive play condition. In a follow-up study, Larson et al. (2014) replicated and extended the Larson et al. (2013) methods by adding a fixed-time attention control in the interactive play condition and evaluating the effects of a brief intervention analysis based on the results of the FA. Additionally, the demand condition from the previous study was not included, as there were no instances of MPVA. Results from both the Larson et al. (2013) and Larson et al. (2014) studies produced the same outcomes. All participants engaged in higher levels of MVPA in the interactive play condition, followed by the attention condition. Little to no responding was observed in both the alone and demand conditions, indicating that the arrangement of those two environments did not produce an increase in levels of MVPA.

Results of Larson et al. (2013) and Larson et al. (2014) were systematically replicated by Zerger et al. (2016). A functional analysis was conducted for seven preschool aged children on their preschool playground. An attention, interactive play, alone, and control condition were
conducted, similar to Larson et al. (2013), specifically to identify a social positive reinforcer for MVPA. Five of seven subjects’ MVPA showed an increase when either adult attention or adult interaction was provided contingent on instances of MVPA, relative to the control condition. The results of the functional analysis were used in an intervention analysis, which is described in the following section.
Physical Activity Interventions

Given that school-aged children spend a majority of their day at school, the school day is an important time in which physical activity can be promoted. Some schools still have recess and physical education (PE) classes as part of their day or curriculum, while other schools have begun to scale back on including breaks for physical activity. Research has looked at promoting physical activity during times of the day already planned for physical activity and incorporating breaks during the school day to increase physical activity.

Classroom-Based Interventions

Fogel et al. (2010) evaluated the effects of an exergaming program on physical activity in four children who were considered to be inactive during regular PE classes. It was identified that there was a potential lack of opportunity for physical activity during PE classes, given the necessary time for frequent instruction. Therefore, the exergaming program was implemented to compare the amount of opportunity for physical activity and the duration of physical activity, with that of regular PE classes. Both exergaming sessions and PE classes were 30 min in duration. The comparison of the two conditions indicated an increase in the amount of opportunity for physical activity, with the exergaming sessions allowing a mean of 11.6 min and regular PE sessions allowing only a mean of 3.8 min. Additionally, the four subjects engaged in more physical activity during exergaming, with a mean of 9.2 min and a mean of only 1.6 min during PE. Using social validity measures, the exergaming procedure was not only preferable by teachers and the students, a teacher report stated that the amount of time needed to alleviate
behavior problems during these sessions was less than that of PE. The results of this study indicate that an exergaming program can be used in a 5th grade classroom to increase the duration of physical activity, as well as opportunities provided for physical activity. These findings were replicated in another study comparing the duration of physical activity during exergaming and PE class with elementary school children (Shayne et al., 2012)

Most recently, Hayes and Van Camp (2015) evaluated the effects of an intervention package including reinforcement and self-management components. The study was conducted during recess for six students in a third grade classroom, capitalizing on a time already allotted in the school day for physical activity. A Fitbit® accelerometer was used to record the number of steps taken during recess. The intervention package evaluated self-monitoring, goal setting, and reinforcement. The self-management component encouraged subjects to look at their step count on the Fitbit® throughout recess sessions. In the goal setting component, the initial goal was set to a 10% increase above the average of each subject’s last four sessions. By the last intervention, the goal was set to a 40% increase. In the reinforcement component, contingent on meeting individual goals, each subject was given a reward, identified through a multiple-stimulus-without-replacement (MSWO) assessment. The intervention was successful at increasing the number of steps taken for four of six participants, with an overall increase of 47% from baseline sessions to intervention sessions. Researchers also evaluated the number of minutes each participant engaged in MVPA. There was an increase in MVPA from 4% of minutes in baseline to 25% of minutes during intervention. Results of the study suggest that an intervention package consisting of self-management, goal setting, and reinforcement can be used to increase step counts and instances of MVPA during recess.
Miller et al. (2018) also conducted a pedometer-based intervention, evaluating the effects of self-monitoring, goal setting, and reinforcement to increase physical activity during school recess. Eighteen 5- to 8-year old children from the same classroom were divided into two teams. Feedback and self-monitoring alone were not sufficient to increase step counts. However, feedback, self-monitoring, goal setting, and reinforcement in combination increased the average number of steps per minute during recess. This study is an example of a simple intervention that is low-cost and did not take away from academic time in the classroom.

**Individualized Interventions**

Interventions aimed to increase physical activity have also been used individually at home and or school settings. Some of these interventions have included the evaluation of feedback and/or reinforcement, and specific environmental variables resulting in increased levels of physical activity.

**Home-Based Interventions**

Roemmich et al. (2004) evaluated the effects of open-loop feedback and reinforcement on a group of children’s physical activity counts in individual homes. Open-loop feedback systems use an individual, other than the target individual, to review the target behavior and provide reinforcement. Subjects ages 10- to 11-years-old who were spending a minimum of 15 hr per week watching television or playing video games, were randomly assigned to either an intervention or control group. Subjects in the intervention group wore an accelerometer throughout the duration of the study and were provided with feedback and reinforcement. The feedback component allowed the subjects to monitor their physical activity counts and record this information in a habit book. Additionally, the amount of time spent in sedentary activities (i.e., television, video games, telephone time, etc.) was also recorded in the habit book.
Contingent on meeting a goal of 400 activity counts, subjects were allowed 60 min of TV time. Subjects assigned to the control group also wore a pedometer, however no feedback or reinforcement was provided throughout any part of the study. Results demonstrated that subjects in the intervention group increased physical activity 24% above baseline levels, and engaged in 22% less television time than the control group. Roemmich et al. (2004) indicated that making a sedentary activity a reinforcer for engaging in physical activity could be used with children in a home setting. Similar findings were also reported in Golfield et al. (2006) who evaluated feedback and rewards in the form of television viewing presented contingent on increased step counts in overweight or obese children.

Ek et al. (2016) evaluated the effects of goal setting and rewards readily available in the home setting, on physical activity as measured by pedometers. Five 8- to 11-year-old children whose BMI indicated them to be overweight or obese, participated in the study. Each subject was fitted with a pedometer to be worn throughout the duration of the study to measure physical activity in terms of step counts. The first intervention consisted of the researcher, subject, and parent identifying an initial step goal. Additionally, researchers identified a reward that was already available in the home to be delivered to the subject contingent on meeting the step goal. A behavior contract indicating the step goal and a reward to be earned was written for each day and signed by the subject and the parent. At the end of each day, the parent checked the pedometer and recorded the number displayed on the screen, followed by giving feedback to the child on whether or not the goal for that day was met. The researcher made contact with each parent to collect the data and ensure reward delivery or the withholding of the reward. The intervention was successful in increasing step counts for three of five subjects. However, subjects were not consistent in meeting their daily goals. Therefore, a second intervention was
introduced that implemented the same procedure as previously described, with additional daily phone calls from the researcher to the parent or subject asking about their progress that day and prompting them to get the steps to meet their goal. Results from the second intervention indicated that the addition of the daily phone calls was successful in two of three subjects meeting their daily goals 100% of the time.

School-Based Interventions

Following the conclusion of functional analyses (FAs) of MVPA for four preschool-aged children, Zerger et al. (2016) conducted an intervention analysis to determine when consequences of MVPA should be provided. Specifically, the results of the FAs for four subjects indicated that adult attention or adult interaction was responsible for increased levels of MVPA on a preschool playground. Given that recommendations by health organizations (i.e., CDC and WHO) suggest that parents become actively involved in children’s physical activity, adult attention and/or interaction should be used by parents to maintain increased levels of physical activity. Therefore, the intervention analysis evaluated the effects of a research assistant providing attention or interaction contingent on MVPA, and the effects of providing that same attention or interaction during according to a fixed-time schedule of reinforcement. The purpose of the analysis was to identify the most appropriate time to deliver reinforcement for MVPA, so that parents could be better informed of how to become actively involved with their children’s physical activity. The results demonstrated that the subjects engaged in more instances of MVPA when the research assistant delivered attention or interaction contingent on MVPA, rather than noncontingently throughout the sessions. This suggests that as parents attempt to promote higher levels of physical activity in children, a potential strategy is to provide attention or interaction contingent on instances of MVPA.
School-Wide Interventions

Interventions have also targeted subjects across several schools to increase physical activity during the school day. For example, Lubans et al. (2009) evaluated a school-based, multicomponent intervention on physical activity, sedentary behavior, and healthy eating in adolescents. The intervention, ProgramX, was administered to 58 students across three schools. Subjects were identified as either already meeting or not meeting regular physical activity requirements. ProgramX, included five components: 1) a school sport program, which focused on teaching lessons of maintaining a healthy lifestyle, 2) information sessions, which focused on physical activity and healthy eating, 3) the use of pedometers for self-monitoring, 4) physical activity and nutrition handbooks, as well as monthly newsletters for parents, and 5) social support sent via email. Although ProgramX was not successful in decreasing sedentary behavior, the intervention was successful in substantially increasing physical activity, as measured with pedometers. Additionally, the program showed a substantial decrease in the amount of energy-dense/low-nutrient snacks and increase in the amount of fruits consumed, by boys and girls respectively.

Horne et al. (2009) adapted the Food Dude Programme, originally used to increase consumption of fruits and vegetables, to increase physical activity in children. This version of the intervention focused on the use of peer modeling and rewards, in addition to step goals measured with pedometers. The adaptation of the program included a personalized letter from the “Fit n’ Fun Dudes” that indicated a step goal for each individual child and a home pack consisting of pictures, songs, and lyrics, and rewards for meeting the daily step goal. Subjects wore pedometers 24 hr per day, Monday through Thursday, and were allowed to monitor their steps throughout the intervention. At the beginning of each school day, researchers checked and
recorded the number of steps taken for the previous day and reset the pedometer. The program was successful in producing a significant increase in the mean number of steps taken per day by girls and boys, increasing to 3822 and 2785 steps above baseline, respectively. Additionally, the study evaluated average steps per day at a 12-week follow-up. Although steps for both girls and boys dropped below levels observed in intervention, there was still an increase above baseline levels. In a follow-up study, Hardman et al. (2011) evaluated the same Fit n’ Fun Dudes intervention described by Horne et al. (2009), but extended the population to children aged 7-11-years-old. In addition to the intervention, another set of subjects participated in a modified version in which no rewards were presented contingent on meeting step goals. Three schools participated, with one receiving the full intervention previously described, one receiving the intervention without rewards, and one receiving no intervention. The findings for the full intervention group were replicated from Horne et al. (2009). The intervention group with no rewards showed slight increases in mean step counts, and the control showed no increase in mean step counts.

Other interventions implemented at school have also targeted the promotion of physical activity in the home setting. For example, Lubans et al. (2011) evaluated the effects of the Physical Activity Leaders (PALs) program on physical activity in 9th grade boys in low socioeconomic (SES) schools. The PALs program focused on the promotion of physical activity, healthy behaviors, and leadership in the school and home settings. The program was made up of six components: 1) enhanced school sport sessions to promote information about physical activity and nutrition, and included teacher-directed activity sessions, 2) interactive seminars to promote leadership roles within physical activity and nutrition, 3) lunch-time physical activity sessions to promote resistance training, 4) physical activity and nutrition handbooks to address
barriers for engaging in physical activity and healthy eating habits at home, 5) physical activity leadership sessions, in which subjects taught younger boys to engage in resistance training, and 6) pedometers for self-monitoring throughout the study. Although PALs did not produce a significant change in physical activity and resistance training activities, the program was successful in reducing BMI and body fat scores, as well as the consumption of beverages containing sugar. In a subsequent study, Lubans et al. (2012) analyzed the potential mediators and moderators of the PALs program previously described. Although there were no changes in physical activity, thereby not meeting the mediation criteria, there was an increase in resistance training self-efficacy. Additionally, baseline weight was identified as a moderator, with the strongest effects on overweight or obese subjects. Results from Lubans et al. (2011) and Lubans et al. (2012) indicate that certain aspects of the PALs program can be used to change healthy behaviors among adolescent boys; however, an increase in physical activity should still be addressed.

Erwin et al. (2011) evaluated the effects of a classroom-based physical activity intervention on physical activity levels of elementary-aged children. The goal of the study was to provide a low-cost method for increasing physical activity, as well as getting teachers involved in students’ physical activity. Subjects were children from two schools, with one school serving as the intervention group and the other school as the control group. Physical activity was measured as step counts recorded with pedometers. Intervention classroom teachers were provided with a brief training on physical activity and its importance in the classroom. Additionally, they were given activity cards to use for activity breaks in the classroom. Teachers were instructed to provide at least one 5-10-min activity break in the classroom every school day. Results of the study demonstrated increases in physical activity in the intervention schools.
compared to the control schools. Similarly, Delk et al. (2014) conducted a study in which 30 middle schools participated in the development of activity breaks to be used in the classroom. The goal of the study was to increase the number of activity breaks that teachers provided throughout the school day. One set of teachers received a basic training about activity breaks, another set of teachers received the training as well as support from a school facilitator, and the final set of teachers received training, a facilitator, plus social marketing. Results of the evaluation indicated that teachers who received training plus support were most likely to provide more frequent activity breaks throughout the school day, relative to the other sets of teachers. Although the results of this study suggest that teachers can adopt activity breaks and provide them frequently across the school day, there was no indication if the activity breaks had any effect on physical activity levels in the classroom.

De Marco et al. (2015) conducted a study with the goal of having classroom teachers incorporate physical activity into their regularly scheduled lessons, both indoors and outdoors. This was called the Be Active Kids Program and was implemented in six classrooms across three childcare centers. Forty activities were created for each individual classroom, and teachers were trained to include physical activity in their educational content. Further, teachers were provided with information to decrease the wait time for activities and increase sedentary or light activities to more intense activities. Results of the study indicated that the activities did not take away from any academic learning time. However, although there was a substantial increase in light movements, there were only slight increases in MVPA movements.
Purpose

Physical activity is an important health related behavior, especially as trends in youth obesity continue to increase. The literature discussed identifies several low-cost measurement systems for different aspects of physical activity (e.g., steps, heart rate, energy exertion). Treatments to increase the amount of physical activity youths engage in have been implemented in classrooms and across schools. This is an ideal environment to target, as children and adolescents spend a majority of their day at school or engaged in other school related activities. It has been identified that although some schools still incorporate breaks for physical activity into their school day (i.e., recess and PE), many schools do not require this to be a part of their schedule. In schools that do not allow for these breaks, interventions should be used to somehow incorporate physical activity into the regularly scheduled curriculum. In schools that do allow breaks for physical activity, these times should be targeted to promote higher levels of physical activity (i.e., MVPA or increased steps). Because recess presents a daily opportunity for physical activity at school, interventions targeting recess can be convenient and accessible. The purpose of the current study was to investigate a class-wide intervention during recess that did not rely on tangible reinforcers to increase children’s physical activity.
Method

Participants and Setting

Sixteen children, ages 9 to 12, participated in the study. Participants were all part of the same upper elementary classroom at a local Montessori school, and each child in the classroom participated. Participants’ parents and teachers signed consent forms, and the local institutional review board approved all aspects of the study prior to participant recruitment and data collection. Researchers did not exclude any of the participants from the study.

All sessions were conducted at the school’s playground 5 days per week during regularly scheduled recess and physical education (PE) periods. Recess occurred on Monday, Wednesday, and Friday at 2:30pm for an average of 29 min each day. PE occurred on Tuesday and Thursday around at 11:15am for an average of 45 min each day. The playground consisted of a large open grassy area, outdoor toys (i.e., sports balls, bouncy balls, Hula Hoops, and jump ropes), and a picnic table. Throughout the study, researchers did not restrict participants to any area of the playground or limit the equipment with which they could play.

Materials

At the beginning of each session, researchers outfitted participants with a pedometer (Model: Yamax DigiwalkerTM CW-200) to track their steps (see Appendix A). This particular model was selected because previous validation research has shown this device to be among the most reliable and accurate in both free-living (Schneider et al., 2004) and structured conditions (Schneider et al., 2003). A metal rack was used to store the pedometers in the classroom while
participants were not wearing them. During both recess and PE sessions, participants wore the pedometer to track their step count.

In addition to the pedometers, researchers stored a bin in the classroom that contained mechanical tape for masking the pedometers, participant folders, a binder with researcher data sheets, and pens for participants to record their steps. The participant teams were provided with a folder that had a data sheet where they would record their individual and combined step counts (see Appendix B). Before the beginning of each recess session, the researcher printed a bar graph on a piece of paper (see Appendix C) that depicted the rank order of teams by their combined step counts.

**Response Measurement and Reliability**

Data were collected on number of steps from the participants’ pedometers. Step counts were reported as steps per minute, and the rates for each participant were summed and divided by the number of participants to yield a mean rate. Reporting the data as a mean rate accounted for varying session lengths and participant absences.

Interobserver agreement (IOA) for step counts was calculated by having two independent observers record the step count from each participant’s pedometer, adding each step count, and calculating an average rate. An agreement was defined as both observers recording the same individual and group step counts, and the same average rate. IOA was calculated for 33% of the recess sessions and 33% of the PE sessions. The mean IOA for both recess and PE sessions was 100%.

**Procedure**

The intervention was evaluated in an ABAB reversal design with an embedded multi-element design. Although data were collected during both recess and PE sessions, the
intervention was only implemented during recess. Participants wore sealed pedometers during PE to serve as a comparison for step counts taken during recess. During all sessions of the study, researchers remained on-site to observe sessions and to monitor any potential misuse of or tampering with pedometers by the participants (e.g., shaking the device). Participants were not observed to engage in any misuse or tampering of the device.

**Baseline**

At the beginning of each recess session, the researcher entered the classroom and informed the participants that they would be putting on their pedometers before going outside. Each participant was assigned an initial participant number and wore a pedometer with the corresponding number. When it was time to begin recess or PE, the researcher instructed the participants to line up to get their pedometers, which were stored on a metal rack in the back of the classroom by the exit door to the playground. Pedometers were sealed shut with mechanical tape and were worn at the hip. Researchers provided assistance for those who needed help putting on the pedometer. Participants were told that their pedometers must remain closed and that they were not allowed to look at their step count during any point of the session or following the session. There were no observed or reported instances of participants breaking the seal to look at the display screen. At the end of the session, participants lined up and walked back into the classroom and placed their pedometer back on the rack. Researchers unsealed the pedometers to record the number of steps and reset the display.

At the end of the first baseline phase, each individual participant’s step count was totaled and averaged across the phase. This allowed us to identify participants with the lowest mean step count and the mean highest step count. Participants were then ranked from 1-16, with participant 1 being the child with the lowest step count and participant 16 being the child with the highest
step count. Although data were collected during both recess and PE, only the step counts that took place during recess sessions were totaled and averaged to use for the ranking of participants.

**Intervention**

Based on the rank order, participant teams were arranged in which a child with a lower step count was paired with a child with a higher step count. For example, the participant with the lowest average step count in baseline (participant 1), was paired the participant with the highest average step count in baseline (participant 16). The participant with the second lowest average step count (participant 2), was paired the participant with the second highest average step count (participant 15). Participants were paired in this way so that the mean number of steps taken by each pair was approximately equal across pairs.

**Intervention at Recess.** Following the pairing of participants, researchers introduced the intervention at the subsequent recess session. Researchers informed the participants of their teammates and asked them to stand beside their partner. The researchers explained to the participants that they were going to be with their partner for the duration of the study. The teams were told that they would be competing against each other to see who could take the most steps. Participants were informed that they could look at the number of their pedometer and any other person’s pedometer at any point throughout recess. Additionally, researchers told participants that if they noticed their partner was lacking movement or not taking many steps, they could encourage one another to take more steps.

Before each session began, researchers showed the class a bar graph that displayed all of the teams’ totals from the previous session, ordered from the team with the highest step count to the team with the lowest step count. The experimenter announced the top three teams to the entire class while showing the bar graph of all eight teams. The bar graph was then placed on the
wall above the pedometer rack where participants could review the display before and after recess. No rewards were provided for the top three winning teams. Following the review of the teams, the participants were lined up and told they could go out to recess. The researchers did not interact with any of the participants while they were out at recess. Once recess was finished, participants lined up at the door and were instructed to sit at the table with their teammate. Each table had two sets of teams arranged with their respective folders that consisted of their step count log (i.e., data sheet). Participants were instructed to open their pedometer, place it on the table, and write down the number of steps on the display. If participants needed help calculating the total or had any questions, they were instructed to raise their hand and a researcher would provide assistance. Once each teammate recorded their step count, they added their combined step count with a calculator from the classroom, and recorded the number. Although participants’ recordings were not used as part of official data collection, it allowed them to monitor their own step count throughout recess, as well as their step count taken as a team. Following participant data collection, participants closed their pedometers and placed them back on the rack.

Researchers collected the folders and placed them back in the bin. Once all the pedometers were returned to the rack, the researcher collected the counts from each of the pedometers and reset the display. The bar graph was then created from the day’s data to display at the following recess session.

**Physical Education Class (PE).** Although the intervention was implemented only during recess sessions, participants wore the pedometers during PE sessions to determine average steps taken during PE. PE sessions were similar to baseline in that participants were instructed to put on their pedometer and proceed outside. However, the pedometers were not sealed with mechanical tape, and participants were allowed to look at their steps. Anecdotally, participants
did not typically open their pedometers or interact with each other as they did during recess sessions. Once PE concluded, participants lined up, went back into the classroom, and placed their pedometers on the rack. Researchers recorded the step count from each pedometer and reset the display.
Results

Figure A1 depicts mean steps per min across participants during recess and PE. In the first baseline phase, participants took a mean of 67 steps per min (range, 49-84) during recess sessions, denoted by the closed circles. During PE sessions, participants took a mean of 55 steps per min (range, 41-66), denoted by the open circles. In the first intervention phase, participants took a mean of 99 steps per min (range, 94-107) during recess and 55 steps per min (range, 45-68) during PE. Mean steps per min substantially increased from baseline during intervention at recess. In the second baseline phase, participants took a mean of 59 steps per min (range, 50-68) during recess, demonstrating a return to initial baseline levels. Participants took a mean of 59 steps per min (range, 57-61) during PE. During the final intervention phase, participants took a mean of 94 steps per min (range, 71-112) during recess, demonstrating an increase back to the level of the first intervention phase. Participants took a mean of 59 steps per min (range, 51-63) during PE. Overall, results indicated a substantially higher mean step rate in recess during both intervention phases relative to baseline phases. The mean step rate in PE stayed at consistent levels across all recess baseline and intervention phases. The comparison of recess and PE sessions provides additional evidence of the effectiveness of the intervention on participant step count.

Figures A2 through A9 depict the mean steps per min for individual participants during recess. All figures are arranged to display the two members of each team. For example, in Figure A2, participants 1 and 16 comprised team 1, in Figure A3, participants 2 and 15 comprised team
2, and so on. In team 1 (Figure A2), participant 1 had some variation in steps across phases and her overall steps were low, but she showed an increase in each intervention phase. Participant 16 had some overlapping data and his mean steps were high throughout the study. He showed an increase in the first intervention phase but in the second intervention phase his level did not exceed the original baseline. Both participants in team 2 (Figure A3) and team 3 (Figure A4) had a substantial increase in mean steps in both intervention phases relative to baseline phases. In team 4 (Figure A5) participant 4 had overlapping data across the first baseline and intervention phases, but mean steps increased substantially in the final intervention phase relative to both baseline phases. Participant 13 had some overlapping data, and mean steps only slightly increased in the final intervention phases relative to baseline phases. In team 5 (Figure A6), participant 5 had a substantial increase in mean steps in both intervention phases relative to baseline phases. Participant 12 had relatively high steps in the intervention phases, but had overlap across both baseline phases. In team 6 (Figure A7), participant 6 had a substantial increase in mean steps in both intervention phases relative to baseline phases.Participant 11’s steps did not show differentiation in steps across both baseline and intervention phases. In team 7 (Figure A8), participant 7’s mean steps substantially increased in both intervention phases relative to baseline phases, while participant 10 did not have any differentiation in steps across all phases. In team 8 (Figure A9), Participant 8 had an increase in the first intervention phase but not in the second intervention phase relative to the first baseline. Participant 9 did not have any differentiation in steps across all phases.

Results indicated that the intervention was successful in increasing the mean number of steps taken in both intervention phases relative to baseline for eight of 16 participants (participants 2, 3, 4, 5, 6, 7, 14, and 15). Four of the participants’ data showed an initial intervention effect and
decrease in the second baseline (ABA effect), but the data in the final intervention phase overlapped with the initial baseline phase (participants 8, 12, 13, and 16). The remaining four participants’ (participants 1, 9, 10, 11) data did not show an effect across phases. Additionally, 12 of 16 participants’ (participants 2-3, 5-8, 11-16) step counts were consistent with the moderate-to-vigorous physical activity (MVPA) guidelines during intervention (i.e., 100 steps per minute).
Discussion

This study showed that children’s physical activity can be increased with an intervention consisting of student pairing, competition, and public posting in a class-wide intervention. Furthermore, this intervention targeted an increase in steps during recess periods in which physical activity can be promoted easily without taking time away from instructional activities. Although results of the study demonstrated the intervention was effective for most participants, it is not clear which aspect of the intervention was responsible for increasing step counts. The change in behavior could be attributed to access to their own and other team’s data that may have occasioned more steps to beat the other teams. Review of the bar graph before each recess session may have served a reinforcing function for teams whose step counts placed them into the top three winning teams, and a punishing function for teams whose steps placed them into the remaining five teams. That is to say, “winning” feedback likely reinforced high rate of step taking during recess, and “non-winning” feedback likely punished sedentary behavior during recess. Additionally, arranging participants into pairs and informing them that they would be competing against one another to see which team could achieve the most steps during recess may have served as an antecedent manipulation functioning to establish the value of recorded steps. Finally, the pairing of participants into teams may have led to teammates reminding each other to take more steps if they were not already doing so. To determine the impact of peer prompts, future research might compare the current intervention with one that programs times throughout
recess during which participants are required to check each other’s pedometers and remind each other to take more steps if they are not already doing so.

The current study has a few implications. The intervention was simple to implement. Children were paired into teams, and they wore pedometers during times already allotted for physical activity at school. The participants put on their pedometers and went outside for their regularly scheduled recess. Data collection was also simple in that researchers recorded the step counts from each pedometer, added the participants’ step counts, and calculated a mean. The costs incurred by researchers also were minimal in carrying out the study. The cost of the pedometer was $16 per device, or $240 for 16 devices (i.e., pedometers could be ordered in bulk for a discounted price). Compared to other mechanical devices, pedometers provide a cost-effective way to measure physical activity. Additionally, the current study did not require the classroom teachers to engage in any behavior related to the intervention. Teachers did not provide any additional support and only directed the children in and out of the classroom for recess and PE as they normally would in their regular school day. Erwin et al. (2011) and Delk et al. (2014) both required teacher training on the importance of physical activity and how to incorporate added breaks into the school day to allow for physical activity. The current intervention did not require teachers to experience any training or engage in any behavior that would have an effect on participant step count.

The ease and efficiency with which the intervention was implemented suggests the potential for initial and continued implementation by others. Future research should evaluate whether teachers or other classroom staff are able to conduct the intervention independently. If teachers were without support to carry out the intervention, it would be feasible for participants to collect their own data and conduct their own reliability checks with one another. In the current
study, participants recorded their steps in their team folder and then walked their pedometer to another table in the classroom to put it away for the day. Therefore, the pedometer recorded additional steps that were not accounted for on the participants’ data sheets. Given this, there were discrepancies between participant and researcher data collection. However, the discrepancies between participant and researcher data collection fell between 15 and 20 steps, suggesting that the reliability between the two methods of data collection was likely high, and teachers may be able to rely on participants to report their own data. Additionally, data collection would not take away from any regular teaching duties, as the participants independently put on their pedometers and recorded their step totals at the end of each recess period during intervention. Finally, the intervention did not require the participants to find new activities to engage in to reach the increased step counts. Participants appeared to engage in the same activities across baseline and intervention phases, but seemed to engage in these same activities at an increased intensity or frequently (e.g., playing soccer games more intensely, jumping rope more often, running faster or for longer durations). Future research should consider the measurement of activity engagement by type and intensity to track more closely why steps are improving as a function of this or other similarly aimed interventions.

Although the intervention increased the overall step count for the classroom and was effective in increasing step totals for most participants, a few limitations should be noted. First, follow up measures of the effects of the intervention were not collected, so it is not clear if the intervention would continue to produce increased levels of physical activity over long periods of time. Second, the effect of the intervention in other contexts was not evaluated, so it is unclear if the effects generalized outside of the school setting. Third, the extent to which the children or teachers found the intervention acceptable or outcomes satisfactory was not determined, as we
did not conduct a social validity assessment. However, anecdotal observations showed that the teachers and students enjoyed participating in the intervention.

There are several areas to consider for future research. One would be to conduct social validity assessments on these same procedures and outcomes. Another would be to collect data on the maintenance and generality of effects. Although the number of steps returned to baseline levels after intervention was removed, suggesting that the results might not maintain in the absence of the intervention, it is possible that a longer period of intervention might contribute to maintenance. A third area of research would be to investigate factors that would make the intervention effective for all participants. There were some participants whose data did not show a reliable or substantial change. For four of these participants, there was an initial intervention effect that was not fully recovered in the final intervention phase. These data suggest that this particular intervention may not have durable effects for all participants. Future research might look into subtle changes in the intervention to sustain increased step counts, such as changing the teams or letting the participants pick their teams. The remaining four participants’ steps did not show a change across any phases. Future research might look into idiosyncratic supports for individuals whose steps were not affected by the ongoing intervention. Nevertheless, 12 of the 16 participants took a mean of 100 steps per min during some, if not all, intervention sessions. This has important implications, as researchers have suggested that 100 steps per minute qualifies, as MVPA (Tudor-Locke et al. (2011a); Tudor-Locke et al., 2011b). Although this number has only been validated as an appropriate amount of physical activity for adults, Tudor-Locke et al. (2011b) suggest that it can be used as the guideline for children and adolescents. Previous studies targeting an increase in physical activity were successful in increasing light movements, but did not produce an increase in movements that constitute MVPA (De Marco et al., 2015).
Another area for future research would be an evaluation of this or similar interventions implemented by the actual classroom teachers or teachers’ aides. Such research could investigate the amount of training needed to get teachers to conduct such an intervention with fidelity and the effects of the intervention on student physical activity. Researchers should also evaluate the acceptability of the intervention to teachers and solicit their input on ways to make it as user friendly as possible for them to implement.

In summary, the current study provided evidence of a simple intervention that can be used to increase physical activity in school-aged children. Schools that follow the guidelines for incorporating breaks for physical activity can use interventions like this one to produce an increase in physical activity, specifically step counts, by their students.
References


APPENDICES
Appendix A: Figures

**Figure A1:** Mean steps per minute across recess and PE sessions for the class.
Figure A2: Mean steps per minute observed across recess for team 1. Asterisks denote the days in which participants were ranked in the top three teams with the highest steps.
Figure A3: Mean steps per minute observed across recess for team 2. Asterisks denote the days in which participants were ranked in the top three teams with the highest steps.
**Figure A4:** Mean steps per minute observed across recess for team 3. Asterisks denote the days in which participants were ranked in the top three teams with the highest steps.
Figure A5: Mean steps per minute observed across recess for team 4. Asterisks denote the days in which participants were ranked in the top three teams with the highest steps.
Figure A6: Mean steps per minute observed across recess for team 5. Asterisks denote the days in which participants were ranked in the top three teams with the highest steps.
**Figure A7:** Mean steps per minute observed across recess for team 6. Asterisks denote the days in which participants were ranked in the top three teams with the highest steps.
**Figure A8:** Mean steps per minute observed across recess for team 7. Asterisks denote the days in which participants were ranked in the top three teams with the highest steps.
Figure A9: Mean steps per minute observed across recess for team 8. Asterisks denote the days in which participants were ranked in the top three teams with the highest steps.
Appendix B: Pedometer (Model: Yamax DigiwalkerTM CW-200)
### Appendix C: Participant Data Sheet

#### Team Daily Steps

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Appendix D: Graphical Display of Feedback Data
October 20, 2014

Bryon Miller  
ABA-Applied Behavior Analysis  
Tampa, FL 33647

RE: Expedited Approval for Initial Review  
IRB#: Pro00017580  
Title: Using Comparative Feedback to Increase Children’s Physical Activity

Study Approval Period: 10/18/2014 to 10/18/2015

Dear Mr. Miller:

On 10/18/2014, the Institutional Review Board (IRB) reviewed and APPROVED the above application and all documents outlined below.

Approved Item(s):
Protocol Document(s):
Protocol
This study involving data pertaining to children falls under 45 CFR 46.404 – Research not involving greater than minimal risk.

Consent/Assent Document(s)*:

Parental Permission.pdf  
Teacher Informed Consent.pdf  
Written Child Assent.pdf  
(Verbal Child Assent)

*Please use only the official IRB stamped informed consent/assent document(s) found under the "Attachments" tab. Please note, these consent/assent document(s) are only valid during the approval period indicated at the top of the form(s). *Verbal Assent is not stamped.

It was the determination of the IRB that your study qualified for expedited review which includes activities that (1) present no more than minimal risk to human subjects, and (2) involve only procedures listed in one or more of the categories outlined below. The IRB may review
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