Comparing an Interdependent and Dependent Group Contingency to Increase Physical Activity in Students During Recess

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Abstract

Physical activity is defined as any body movement that requires energy expenditure. It has important physiological, mental health, academic, and cognitive benefits for children and youth. Despite these advantages, a large proportion of this population does not meet the minimum recommended amount of physical activity. Recent studies have shown that the interdependent group contingency (IGC) and dependent group contingency (DGC) improve physical activity; however, no comparison of the effects of these group contingencies on physical activity has been conducted. We used a multielement within a concurrent multiple baseline across classes design to compare the effectiveness of these group contingencies to increase physical activity in two classes of grade 5 students. Both group contingencies increased physical activity in both classes, with the IGC producing slightly higher levels of physical activity than the DGC at the class-wide and individual levels of analyses. Conversely, side effect data suggest that participants in both classes preferred the DGC. Results are discussed within the context of treatment decisions and suggestions for future research.

Keywords: physical activity, interdependent group contingency, dependent group contingency, recess, positive and negative statements

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Table of Contents

Comparing an Interdependent and Dependent Group Contingency to Increase Physical Activity in Students During Recess

The World Health Organization (WHO; 2018) defines physical activity as any "bodily movement produced by skeletal muscles that requires energy expenditure." This includes activities such as walking, dancing, playing at the park, and even completing chores. Incorporating regular physical activity is a critical component of a healthy lifestyle and is associated with several physiological, mental health, academic, and cognitive benefits. With respect to physiological processes, regular physical activity increases neuromuscular awareness (WHO, 2011), muscular and cardiorespiratory fitness, and bone density; improves balance; and ensures healthy growth and development (WHO, 2018). Further, regular physical activity reduces the risk of or prevents the development of many chronic diseases, including hypertension, stroke, type 2 diabetes, coronary heart disease, and cancer (WHO, 2018).

In addition to these physiological benefits, regular physical activity can positively impact children and youth's mental health. This is particularly important given the current prevalence rates of mental health challenges in this population. Globally, 10%-20% of children and youth between the ages of 10-19 years face mental health challenges (WHO, 2019). The most common mental health challenges children and youth experience are depression, anxiety, attention-deficit/hyperactivity disorder, conduct disorder, psychosis, and eating disorders (WHO, 2019). Regular physical activity has been found to decrease symptoms of depression and anxiety (WHO, 2018); improve self-esteem; and provide opportunities for social interaction (WHO, 2011).

Physical activity has also been found to have academic and cognitive benefits for children and youth (Rasberry et al., 2011). Researchers have demonstrated the relation between

increases in physical activity and improved academic achievement in various subjects: including, reading, mathematics, language arts or English, and science (Fedewa & Ahn, 2011). More generally, when Rasberry et al. (2011) systematically reviewed the literature, they found that engaging in physical activity during scheduled breaks in the classroom, gym class, recess, and throughout other periods of the school day resulted in increased academic achievement, academic behaviour, and cognitive functioning skills and attitudes. Therefore, it seems prudent to incorporate regular opportunities for physical activity throughout the school day.

Despite the numerous benefits, many children and youth are not reaching the advised daily minimum amount of physical activity. It is recommended that individuals 5-17 years of age engage in at least 60 min of moderate to vigorous physical activity per day (e.g., brisk walking, biking, rollerblading, skating) and at least three instances of vigorous-intensity physical activity per week (e.g., running, playing organized sport; WHO, 2018). Unfortunately, 81% of youth 11-17 years of age globally do not engage in enough physical activity (WHO, 2018). This difference is amplified by sex, with female youth tending to be less physically active than their male counterparts (WHO, 2018). These statistics are particularly alarming given the numerous risks associated with physical inactivity, such as energy imbalance; low bone density, which can lead to osteoporosis; and an increased risk of obesity, type 2 diabetes, and several types of cancer (Centers for Disease Control and Prevention, 2018).

Given the health benefits of regular physical activity and the serious health risks of not engaging in regular physical activity, it seems prudent to improve the number of opportunities for children and youth to engage in physical activity. There are several factors that influence children's level of physical activity; namely, their parents' activity level, time outdoors, involvement in extracurricular activities outside of school, and the number of physical activity

opportunities during the school day (Statistics Canada, 2017). The WHO (2018) recommends that schools develop policies and arrange several opportunities for physical activity to increase children and youth's physical activity throughout the school day. The number of opportunities for physical activity that schools provide varies across Canada and the United States based on grade level and province or state (Springboard to Active Schools, 2019; Heart and Stroke Foundation, 2017). Only 22% of children in Canada and 45% of children in the United States have daily physical activity breaks in school (Springboard to Active Schools, 2019; Heart and Stroke Foundation, 2017). These statistics show that schools in Canada and the United States are not providing children and youth with a sufficient number of opportunities for physical activity to meet the daily minimum recommended levels. However, the WHO (2007) recommends that school provide sufficient opportunities for physical activity to increase the likelihood that all children and youth meet the minimum daily requirement. This is particularly important because not all children and youth have the same opportunity to participate in extra-curricular activities to help them meet the daily physical activity requirements.

Given the enhanced opportunities that schools can offer to increase children and youth's physical activity, it is not surprising that researchers have increased their focus on evaluating the effectiveness of behavioural interventions in schools (e.g., gym class, recess) to increase children and youth's physical activity. One of these interventions, group contingencies, has been shown to successfully increase elementary school-aged children and youth's physical activity during gym class (Normand & Burji, 2020; Vidoni et al., 2012; Vidoni et al., 2014), recess (Foote et al., 2017; Galbraith & Normand, 2017), and over the entire school day (Kuhl et al., 2015).

Group Contingencies

Group contingencies are empirically supported behavioural interventions designed to target the behaviour of individuals in a group simultaneously (Bushell et al., 1968). Group contingencies involve the delivery of a consequence to some or all members of the group contingent on the behaviour of an individual member, a subset of the group, or the entire group (Litow & Pumroy, 1975). There are three types of group contingencies: independent, interdependent, and dependent (Litow & Pumroy, 1975). While they share the overall goal of simultaneously altering the behaviour of the group, the specific manner in which the contingency is arranged differs.

Since group contingencies target the behaviour of individuals in a group simultaneously, it is not surprising that teachers have reported group contingencies are effective and acceptable to use with their students (Alric et al., 2007; Donaldson et al., 2018; Hartman & Gresham, 2016; Lynch et al., 2009; Theodore et al., 2001; Theodore et al., 2004). This is likely why group contingencies have been implemented in various locations within the school, such as the academic classroom (Barrish et al., 1969; Beeks & Graves, 2016; Brantley & Webster, 1993; Briesch et al., 2013; Bulla & Frieder, 2018; Caldarella et al., 2015; Christ & Christ, 2006; Clair et al., 2018; Dart et al., 2016; Foley et al., 2019; Groves & Austin, 2017; Hansen & Lignugaris/Kraft, 2005; Hawkins et al., 2017; Heering & Wilder, 2006; Jones et al., 2008; Lum et al., 2019; Pokorski et al., 2019; Trevino-Maack et al., 2015; Williamson et al., 2009), gym class (Normand & Burji, 2020; Vidoni & Ward, 2006; Vidoni et al., 2012; Vidoni et al., 2014), hallway (Campbell & Skinner, 2004; Deshais et al., 2018), cafeteria (Williamson et al., 1992), and recess (Foote et al., 2017; Galbraith & Normand, 2017).

The majority of participants in group contingency studies conducted in schools are children and youth between 6-18 years of age. While the vast majority of participants in these studies were typically developing children, group contingencies have been studied with individuals with a variety of disorders and diagnoses, such as: learning disabilities (Jones et al., 2008; Pokorski et al., 2019; Trevino-Maack et al., 2015; Williamson et al., 2009), attention-deficit/hyperactivity disorder (Schanding & Sterling-Turner, 2010), and emotional disturbances (Denune et al., 2015; Hansen & Lignugaris/Kraft, 2005; Hawkins et al., 2015; Hawkins et al., 2017; Pennington & McComas, 2017; Popkin & Skinner, 2003).

Independent Group Contingency

In this type of group contingency, an individual student receives a reinforcer if they meet the predetermined criterion (Litow & Pumroy, 1975). This intervention has successfully increased behaviours such as academic engagement (Dart et al., 2016; Lum et al., 2019), on-task behaviour (Dart et al., 2016), social interactions between students (Pokorski et al., 2019), written work (Trevino-Maack et al., 2015), and active classroom responding (Trevino-Maack et al., 2015). It has also been used to decrease behaviours such as inappropriate behaviour (Brantley & Webster, 1993) and classroom disruptions (Lum et al., 2019). For example, Brantley and Webster (1993) used an independent group contingency to decrease inappropriate behaviour in a grade 4 class. Students earned a checkmark during every interval they engaged in specific prosocial behaviours incompatible with the target inappropriate behaviours. The criterion for each student was the same – to acquire a predetermined number of checkmarks by the end of the week. Only the students who met the weekly criterion received the reinforcer they selected at the beginning of the week. Researchers found that the independent group contingency decreased class-wide levels of inappropriate behaviour to acceptable levels.

Interdependent Group Contingency (IGC)

In this type of group contingency, the entire group receives a reinforcer if the whole group meets the predetermined criterion (Litow & Pumroy, 1975). The criterion can be applied to each student (e.g., each student must correctly answer 10 math questions) or can be applied to the whole group (e.g., the whole class must say a total of 30 positive peer statements daily). If one or more students in the group do not reach the criterion, no one in the group receives the reinforcer. The vast majority of group contingency research in schools has focused on the evaluation of the IGC. Researchers have demonstrated the effectiveness of the IGC to increase behaviours such as class participation (Cheatham et al., 2017), on-task behaviour (Denune et al., 2015; Leflot et al., 2013; Pennington & McComas, 2017), academic engagement (Caldarella et al., 2015; Christ & Christ, 2006; Clair et al., 2018; Collins et al., 2017; Hernan et al., 2019; Popkin & Skinner, 2003), social and supportive interactions (Groves & Austin, 2017; Kohler et al., 1990; Popkin & Skinner, 2003), homework completion and accuracy (Little et al., 2010; Reinhardt et al., 2009), and physical activity (Foote et al., 2017; Galbraith & Normand, 2017; Kuhl et al., 2015; Normand & Burji, 2020). Researchers have also demonstrated the effectiveness of the IGC to decrease behaviours such as inappropriate behaviour (Barrish et al., 1969; Donaldson et al., 2011; McGoey et al., 2010), off-task behaviour (Clair et al., 2018), disruptive behaviour (Beeks & Graves, 2016; Caldarella et al., 2015; Christ & Christ, 2006, Clair et al., 2018; Foley et al., 2019; Groves & Austin, 2017), transition time between classes (Campbell & Skinner, 2004; Hawkins et al., 2015), and cell phone use during class (Hernan et al., 2019; Jones et al., 2019).

For example, Galbraith and Normand (2017) evaluated the effects of a version of the IGC, called the Good Behaviour Game, on the number of steps a class of grade 3 students took

during recess. The researchers split the class into two teams and the students on the team that increased their step count from baseline levels the most each received a raffle ticket for entry into the school-wide lottery program. If the difference between the teams was less than 50 steps, students on both teams received raffle tickets. The researchers found that both teams increased their step counts from baseline levels.

Dependent Group Contingency (DGC)

In this type of group contingency, the entire group receives a reinforcer if the target student or a subset of students in the group meets the predetermined criterion (Litow & Pumroy, 1975). This is often referred to as the "hero procedure" (Cooper et al., 2007) and the target student(s), often referred to as the hero(es). They can change across sessions and can either be specifically chosen or can be selected at random. In addition, the hero can be identified or unidentified to the class. When the hero is identified, they can be revealed before the session or after the session if the hero met the criterion. Most often, the hero is unidentified (Bulla & Frieder, 2018; Vidoni et al., 2012; Vidoni et al., 2014; Williamson et al., 2009) or identified only after the session if the hero met the criterion (Cariveau & Kodak, 2017; Deshais et al., 2019; Jones et al., 2008; Vidoni & Ward, 2006). This is likely because many researchers have hypothesized that identifying the hero a priori can produce unintentional detrimental side effects for the hero, especially if the group does not receive reinforcement (Jones et al., 2008; Williamson et al., 2009). Further, Vidoni et al. (2012) suggested that not identifying the hero before a session encourages all students in the group to cooperate together to achieve a common goal rather than to compete against each other. Recently, there has been an increase in the use of the DGC in which the hero is identified after the session if the hero(es) met the criterion. This may be due to the potential for positive side effects (e.g., positive attention, praise) if the hero

earns the reinforcer for the group. For example, Jones and colleagues (2008) suggested that identifying the hero after the session if they met the criterion provided students and teachers the opportunity to give the hero social positive reinforcement for meeting the criterion and earning the reinforcer for the group.

The DGC has been used to increase behaviours such as student engagement (Cariveau & Kodak, 2017); on-task behaviour (Bulla & Frieder, 2018; Heering & Wilder, 2006; Williamson et al., 2009); positive verbal statements (Hansen & Lignugaris/Kraft, 2005); physical, gestural, or verbal supportive behaviour (Vidoni & Ward, 2006); mathematic estimation (Williamson et al., 1992); and even teeth cleanliness (Swain et al., 1982). It has been used to decrease behaviours such as disruptive behaviour in the classroom (Jones et al., 2008) and in the hallway (Deshais et al., 2018). For example, Cariveau and Kodak (2017) implemented a DGC in a grade 2 class to increase academic engagement. The researchers split the students into three groups such that one student from each group served as the hero each session. If the hero met the academic engagement criterion for the session, the entire group received reinforcement and the hero was identified to the group. They selected this iteration of the DGC to reduce any negative consequences for the hero if they did not meet the criterion. The researchers found all the students increased or maintained a high level of academic engagement from baseline sessions.

Physical Activity

Recently, there has been an increase in the use of group contingencies to increase children and youth's physical activity at school – particularly the IGC (Foote et al., 2017; Galbraith & Normand, 2017; Kuhl et al., 2015; Normand & Burji, 2020) and the DGC (Vidoni et al., 2012; Vidoni et al., 2014). Interestingly, all studies evaluating the effects of the DGC to

increase physical activity used an unidentified hero, presumably because of the aforementioned potential consequences of identifying the hero. Regardless of the group contingency being evaluated, there are some noteworthy similarities across all studies. First, the vast majority of researchers measured the number of steps students took using a pedometer to measure physical activity (Foote et al., 2017; Galbraith & Normand, 2017; Kuhl et al., 2015; Normand & Burji, 2020; Vidoni et al., 2014). In fact, only one study used an alternative measure of physical activity – a heart rate monitor (Vidoni et al., 2012). Second, the majority of studies implemented group contingencies during periods when students had the opportunity to engage in physical activity – gym class (Normand & Burji, 2020; Vidoni et al., 2012; Vidoni et al., 2014) or recess (Foote et al., 2017; Galbraith & Normand, 2017). Only one study looked at increasing physical activity across the whole day (Kuhl et al., 2015).

While most studies evaluated the effects of group contingencies on physical activity during gym class, it might be more ideal for researchers to conduct this research during recess. This is because the different instructional activities that a teacher may arrange during gym class may impose a ceiling on the amount of physical activity children and youth can engage in during class. In this sense, gym class resembles a restricted operant arrangement where students are limited in what, and possibly how much, physical activity they can engage in because the teacher dictates the activity. In contrast, recess resembles a free operant arrangement where students can engage in any form or amount of physical activity without any imposed restrictions outside of safety protocols. Therefore, it seems as though evaluating the effects of group contingencies on physical activity might be best suited for recess when there are no limitations on physical activity.

Side Effects

Side effects typically refer to non-target behaviours that are influenced by the implementation of a group contingency (Payne et al., 2017). Several researchers have recommended one group contingency – or one iteration of a group contingency – over another based on side effect information. This could be due to the fact that all group contingencies have been found to be effective at producing the desired behaviour change (Payne et al., 2017). While most researchers have provided anecdotal information on side effects, two noteworthy studies systematically evaluated the conditions under which side effects were more or less likely to occur.

Speltz and colleagues (1982) compared the effectiveness of the independent group contingency, IGC, DGC (unidentified hero), and DGC (before-session identified hero) on the academic behaviour of school-aged children and found that all group contingencies were equally effective. The researchers also measured the frequency of positive, negative, and neutral statements when each group contingency was implemented. The researchers found that the frequency of negative statements was low and similar across the group contingency conditions. Only positive statements increased significantly from baseline levels, and that this change was observed during both iterations of the DGC. This finding is particularly interesting in light of researchers' hypothesis that identifying the hero a priori might produce negative social side effects (e.g., bullying) for the hero.

Recently, Payne and colleagues (2017) compared the effects of the independent group contingency, IGC, and DGC (before-session identified hero) on problem behaviour and on-task behaviour with two groups of preschool students and also found that all three group contingencies were equally effective. They also analyzed the mean frequency of positive and

negative vocalizations that occurred under each condition and found that (a) negative vocalizations tended to increase during sessions in which problem behaviour occurred, (b) negative vocalizations decreased and positive vocalizations increased during sessions in which students earned the reinforcer, and (c) positive vocalizations increased during all group contingencies relative to baseline. This latter finding is similar to that obtained by Speltz et al. (1982) who also found that positive statements increased during the DGC when the hero was identified before the session. These findings conflict with previous researchers' rationales for not identifying the hero before DGC sessions, and rather, lend support for identifying the hero before the session. These findings highlight the importance of systematically measuring side effects to identify the conditions under which they are more or less likely to occur.

Group Contingency Comparisons

Within the context of the entire group contingency literature (including studies conducted outside of schools), there have been a relatively small number of studies comparing the effectiveness of all three group contingencies. That is, only nine studies compared all three group contingencies (Alric et al., 2007; Ennis et al., 2016; Gresham & Gresham, 1982; Lynch et al., 2009; Payne et al., 2017; Shapiro & Goldberg, 1986; Speltz et al., 1982; Theodore et al., 2004; Vargo & Backnell, 2019), and all were conducted with children and youth in schools. This body of research has produced inconsistent results in terms of which group contingency is superior. In two studies, the IGC and DGC were equal and superior to the independent group contingency (Gresham & Gresham, 1982; Speltz et al., 1982). The remaining studies determined that all three group contingencies were equally effective at producing the desired behaviour change (Alric et al., 2007; Ennis et al., 2016; Lynch et al., 2009; Payne et al., 2017; Shapiro & Goldberg, 1986;

Theodore et al., 2004; Vargo & Backnell, 2019). Teacher and student preference were rarely evaluated, but when they were, the findings were also mixed across studies.

There have been many more comparisons of two group contingencies and 29 were conducted with children and youth in schools. This body of research has also produced inconsistent results in terms of which group contingency was most effective. Of these 29 studies, 22 compared the independent and the interdependent group contingencies; 10 studies found that the IGC was more effective than the independent group contingency (Brown & Reschly, 1974; Brown et al., 1974; Hamblin et al., 1971; Jacobs, 1974; Lloyd et al., 1996; Long & Williams, 1973; McLaughlin, 1981; McLaughlin, 1982; McReynolds et al., 1981; Nevin et al., 1982) and 12 studies found that both group contingencies were equally effective (Axelrod, 1973; Crouch et al., 1985; Ellery et al., 1975; Grandy et al., 1973; Groves & Austin, 2017; Herman & Tramontana, 1971; Levin, 1973; Page & Edwards, 1978; Perline & Levinsky, 1968; Ruedebusch, 1979; Stewart & McLaughlin, 1986; Wodarski et al., 1972). Three studies compared the independent and the dependent group contingencies; one study found that the independent group contingency was more effective than the DGC (Gross et al., 2016), one study found that the DGC was more effective than the independent group contingency (Nevin et al., 1982), and one study found that the most effective group contingency was different across participants (Deshais et al., 2019). Finally, four studies compared the IGC and the DGC; three studies found that both group contingencies were equally effective (Goldberg & Shapiro, 1995; Hartman & Gresham, 2016; Scott et al., 2017) and one study found that the most effective group contingency was different across participants (Gamble & Strain, 1979). Similarly, teacher and student preference were rarely evaluated, but when they were, the results were mixed across studies.

Taken together, a sizable body of research has been conducted on the effectiveness of group contingencies, and across studies, findings have been mixed. Despite these mixed findings, one common theme among these comparative studies is that all group contingencies were effective and none of them were rated as nonpreferred, further supporting the utility of group contingencies.

To date, there have not been any comparisons of the effectiveness of group contingencies to increase physical activity. Researchers have shown that the IGC (Foote et al., 2017; Galbraith & Normand, 2017; Kuhl et al., 2015; Normand & Burji, 2020) and the DGC (Vidoni et al., 2012; Vidoni et al., 2014) increase physical activity; however, what remains unknown is which group contingency is most effective and efficient to increase class-wide levels of physical activity. Therefore, the purposes of this study were to compare the effectiveness of the interdependent and dependent group contingencies on the amount of physical activity students engage in during recess and to systematically evaluate whether either, or both, group contingencies produced side effects. To this end, we assessed the extent to which positive and negative statements occurred given (a) the group contingency in effect, (b) the period of the visit (presession or postsession), and (c) whether the contingency requirement was met and the participants earned a reward.

Method

Participants, Setting, and Materials

We recruited 49 students (28 girls and 21 boys) from two fifth-grade general education classrooms at two public schools in an urban city in Southern Ontario, Canada; one of which was a French Immersion classroom and the other was an English classroom. After we obtained Research Ethics Board approval, we contacted principals to ask if this study could be conducted at their schools (Appendix A) and to identify teachers who were interested in participating. We

met with interested teachers to review the procedures, participation requirements, and teacher consent form (Appendix B). Next, we sent the student consent form (Appendix C) home with all students in the class. Finally, the researcher held individual meetings with each student (hereafter referred to as participants) to review the assent form (Appendix D) and obtain assent; all participants gave their assent at this time. The researcher reminded participants before each session that they could withdraw assent at any time.

If a participant withdrew assent before, during, or after recess, their step count was not recorded for that session and the researcher noted that the participant withdrew assent (as opposed to being absent) on the datasheet. The participant remained in the classroom during the postsession period and received the reward with the entire class, if applicable. One participant withdrew assent on four consecutive sessions at which point, the researcher met with the participant individually and confirmed that they no longer wished to participate in the study and reminded the student that they were still eligible to receive the class reward, when applicable. All students in the class, regardless of whether or not they participated in this study, received the reward with the entire class.

All visits occurred on the school property during morning or afternoon recess. All visits consisted of a presession and session period; the group contingency comparison phase also included a postsession period. For both classes, the mean presession period duration was 8.94 min (range, 5.13 to 14.34 min) and took place in the classroom. The mean session duration was 14.56 min (range, 9.39 to 17.42 min). It began in the classroom when the last participant received their pedometer, continued as the participants went outside to the playground area for recess, and concluded when the first participant returned to the classroom. The mean postsession period duration was 1.75 min (range, 0.17 to 6.38 min). It began when the researcher announced

to the class whether or not they received the reward and concluded when all participants received the reward or when the teacher began the lesson after the researcher announced that the class did not receive the reward. We did not conduct a session when the entire class had to stay indoors for recess (i.e., in the case of inclement weather). The entire visit was approximately 35 min.

During all visits, materials included one Yamax SW 200 Digi Walker pedometer per participant. We selected these pedometers because they have been validated for research use with children (Barfield et al., 2004). We also used waistbands to attach pedometers when participants wore a dress, onesie, or overalls; tape to seal the pedometers while the participants wore them to prevent tampering; and a bin to store pedometers. In addition we used: the timer application on an iPhone, paper and excel datasheets, a video camera, tripod, two mason jars (one contained individual slips of paper with pedometer numbers and the other contained individual slips of paper with the names of potential rewards, this allowed us to randomize our selection of the hero and reward), two sets of coloured armbands (blue for the IGC condition and red for the DGC condition), and a variety of rewards based on results of the indirect preference assessment.

Experimental Design

We compared the effectiveness and efficiency of an IGC and DGC using a multielement within a concurrent multiple baseline across classes design.

Response Measurement and Data Analysis

The primary dependent variable was *step count*, defined as the number of steps each participant took during the session, as measured by the Yamax SW 200 Digi Walker pedometer. All participants wore pedometers irrespective of any mobility restrictions (e.g., broken leg). However, we only used pedometer data from participants who were physically able to take steps at recess because our validated pedometer was only capable of recording step count. We

converted the raw step count data to a mean number of steps per minute (a) for the class and (b) for individual participants. For class-wide data analysis, we divided the sum of all participant step counts by the number of participants and divided this quotient by the session duration. For individual participant data analysis, we divided each participant's step count by the session duration. We did not include a participant's step count data in the class-wide or individual data analysis for a session if they tampered with their pedometer or if it fell off during the visit.

As a secondary measure, trained observers also collected data on the rate of vocal side effects during the presession and postsession periods by dividing the number of each type of statement by the duration of time statements were recorded. Observers scored a *positive statement* when a participant verbally indicated support, praise, encouragement, comradery, or friendship regarding increasing physical activity, potential rewards, or unrelated to physical activity (e.g., "I had so much fun playing soccer with you this recess", "yay, we won!"). Observers scored a *negative statement* when a participant verbally indicated anger, frustration, or disappointment regarding physical activity, the potential rewards, or unrelated to physical activity (e.g., "I can't believe you sat all recess, that's not cool", "I hate the blue game"). We also analyzed the mean rate of positive and negative statements per condition (baseline, IGC condition, and DGC condition). We calculated this by dividing the rate of each type of statement in a specific condition by the total number of sessions in that condition. Finally, we analyzed the mean rate of positive and negative statements made during the postsession period when the contingency requirement was met and the participants earned the reward or not. We calculated this by dividing the rate of each type of statement when the participants earned the reward or when they did not by the total number of sessions when they earned the reward and when they did not. None of the side effect data were considered when making data-based decisions.

Interobserver Agreement and Procedural Integrity

A second, trained independent observer collected data on step count and positive and negative statements either simultaneously or post hoc (via video recording) during 34.0% (range, 28.6% to 42.9%) of all visits. For step count, we calculated total count IOA by dividing the smaller step count by the larger step count and multiplying by 100%. Mean agreement was 99.7% (range, 96.0% to 100%) for step count. For positive and negative statements, we divided the period into continuous 10-s intervals. Then we calculated interval-by-interval IOA by dividing the number of intervals with an agreement by the number of intervals with an agreement plus the number of intervals with a disagreement and multiplying by 100%. An agreement was defined as both observers scoring the occurrence or nonoccurrence of the same statement within a given interval. A disagreement was defined as both observers scoring the occurrence or non-occurrence of a different statement within a given interval. Mean agreement was 98.2% (range, 71.4% to 100%) for positive statements and 97.9% (range, 85.7% to 100%) for negative statements.

Trained observers collected procedural integrity either during the visit (Appendix E) or post hoc (via video recording) during 31.0% (range, 28.6% to 33.3%) of the sessions. Observers collected data on the accuracy with which the researcher implemented presession, session, and postsession contingencies (described below) by dividing the number of researcher accuracies by the number of researcher accuracies plus inaccuracies and multiplying by 100%. An accuracy was defined as the researcher correctly completing a target behaviour on the checklist and an inaccuracy was defined as the researcher not completing or incorrectly completing a target behaviour on the checklist. Mean procedural integrity for all researcher behaviours was 100%.

Presession Period Behaviours

Observers recorded the accuracy with which the researcher delivered the correct script, correctly selected a hero, handed out the pedometer on the correct setting, and handed out the correct coloured armbands, if applicable. Observers scored correct script delivery when the researcher read the correct condition-specific script to the class before the session. Observers scored correct hero selection when the researcher randomly selected the pedometer number of the hero before the session. Observers scored correct pedometer setting when the researcher set each participant's pedometer to 0 before closing and taping the case before the session. Finally, observers scored correct armband colour when the researcher provided participants with the correct coloured armband before the session.

Postsession Period Behaviours

Observers recorded the accuracy with which the researcher delivered the correct script, randomly selected a reward, and delivered the reward. Observers scored correct script delivery when the researcher read the correct script to the class based on whether the class received the reward or not. Observers scored correct reward selection when the researcher randomly chose the reward for the class after the session when the participants earned the reward. Observers scored correct reward delivery when the researcher (or teacher) provided the reward to the class during the next potential opportunity.

Procedure

Preference Assessment

The researcher conducted an indirect preference assessment with each participant to identify a list of the five highest ranked items among the class to use as rewards in both experimental conditions. The researcher first consulted with the teacher to develop a list of 10

potential items and activities that were readily available and appropriate for the participants, but that they did not have free access to on a regular basis (e.g., gum, gel pens). Next, the researcher provided each participant a sheet of paper with this list (see Appendix F). Each participant ranked their top five items, where 1 was their top choice and 5 was their last choice. Participants put an 'X' beside any items they did not like at all. We selected the class' top five preferred items and activities from the results of this survey to randomly select during the group contingency comparison phase. We ensured that at least two of each participant's top three selections were used as rewards and, if possible, we tried to ensure that items that participants marked with an "X" were not used.

Class A's rewards were gum that they could chew during class, candy canes, sour candy, hot chocolate, and 15 minutes of free time. Class B's rewards were pencils, gel pens, highlighters, colouring pages, and an extra 5 minutes of recess.

Pedometer Training

We numbered each pedometer on the inside and outside of the case and assigned each participant a pedometer number that remained consistent for the duration of the study. This controlled for interinstrument error by ensuring that any change in the participant's step count was not the result of a change in the device; if there was a difference between the number of steps a participant took and the step count recorded by the pedometer, this difference remained consistent throughout the study.

Before baseline, the researcher taught the participants how to wear the pedometers. We did this to (a) ensure all participants could independently put the pedometers on in the correct place (front of the left hip), (b) ensure all participants wore the pedometer correctly throughout the entire session, and (c) minimize the threat of reactivity. The researcher continued pedometer

training until the class showed a stable or consistent pattern of mean steps per minute. The researcher provided the below instructions to teach the participants how to put on and remove the pedometers.

> Hi everyone! For today and the next few recesses we're going to practice how to wear the pedometer. I have to make sure you're wearing it right before we can start playing the games. This is called a pedometer <points to pedometer>. And it can tell how many steps you take. You wear it on the front of your left hip like this <demonstrate>. Everyone's going to wear one for the whole recess. It's really important that you don't take your pedometer off or open the case because it'll stop working! To help make sure it stays closed, I will tape the pedometer.
>
> I'll be standing by the door you use to go outside for recess. If your pedometer falls off, come to me and I'll help you put it back on. I will use this video camera <show participants video camera> to record you putting the pedometer on before recess and taking the pedometer off after recess to make sure you are wearing it in the right spot. Remember, if you don't want to play the game at any point, you can let me know and put your pedometer in the blue bin. Any questions? When you come up to me just say your first name and I'll give you your pedometer. Does anyone have any questions? Time to line up!

General Procedure

The researcher used a video camera to record the presession and postsession periods to collect data on step count, positive and negative statements, and researcher behaviours. For confidentiality purposes, the video camera was directed at the floor or the pedometers to ensure that the participants' faces were not captured in the recording. Before handing out the

pedometers, the researcher recorded which participants were in class that day and if they withdrew assent (see Appendix E). During the presession period for all conditions, the researcher read the condition-specific script and told the participants which condition was in effect that session. She asked participants to line up for recess and handed out the pedometers to the participants. She focused the video camera on the pedometer to show the pedometer number, the step count set to 0, and the pedometer placement on each participant. Next, the researcher sealed the pedometer with a small piece of tape to ensure it remained closed during the session. The researcher also handed out the appropriate coloured armbands to all participants, if applicable. Each condition was associated with no armband (baseline), a blue armband (IGC), or a red armband (DGC). The researcher stopped video recording when the participants went outside for the session. The researcher began the timer when the last participant went outside for the session to record the session duration.

During the session (recess), the researcher watched the participants from the main exit to the playground to observe if they attempted to open, remove, or otherwise tamper with the pedometers. This never occurred during this portion of the visit for either class. The researcher was also available in the event that any participant chose to withdraw assent, which rarely occurred during this portion of the visit.

Following the session, participants entered the classroom in single file; the researcher stopped the timer when the first participant returned to the classroom. The researcher video recorded each participant's pedometer when they returned from the session to show the tape sealing the pedometer, the pedometer number, and the pedometer placement on each participant. The researcher collected each participant's pedometer and provided them with brief neutral praise for wearing the pedometer correctly and not trying to open, remove, or otherwise tamper

with the pedometer. When a participant tampered with the pedometer, the researcher issued a brief neutral comment reminding them that it was important to leave the pedometer closed and on their hip during the session and did not include the participant's step count data when calculating class and individual participant mean steps per minute for that session. Next, the researcher took the pedometers outside of the room to enter each participant's step count and the session duration in an excel datasheet and calculated the class and individual participant mean steps per minute.

Baseline

There were no programmed consequences for the number of steps participants took. At the start of the presession period, the researcher said:

> Hi everyone! Now that you all know how to wear your pedometers properly, we need to see how many steps you're taking before we play the games. For the next few recesses that is what we'll do. You can play as much or as little as you want during recess. It's up to you. You have to wear the pedometer the same way we practiced, on your left hip and closed. Don't take it off or shake it or it'll stop working. I'll be by the door if you need me or don't want to wear it anymore. Any questions?

We calculated one step goal for each participant for use in both conditions. For all participants, we calculated a 5% increase from their mean baseline steps per minute by adding the mean number of steps per minute the participant took during baseline, divided this by the number of baseline sessions, and multiplied this quotient by 1.05. We used individual step goals to ensure that (a) step goals were challenging yet attainable for each participant and (b) each participant had the opportunity to contact the health benefits of physical activity.

Group Contingency Comparison

We quasirandomly alternated two conditions during this phase: (a) IGC and (b) DGC by conducting no more than two consecutive sessions of the same condition. During the presession period of the first visit in this phase, the researcher told the participants the five rewards selected for use in this study based on the results of the indirect preference assessment. After each session, the researcher inputted the session duration and participants' step count into an excel document that automatically calculated the session mean steps per minute and compared these values to the calculated step goal to determine if the class earned a reward for that session. The postsession period was the same for both conditions. It began when the researcher returned to the class and announced to the participants whether or not they received the reward. If the contingency requirement was met during the IGC or the DGC, the researcher said to the class, "Congratulations, today everyone took more steps and everyone will get a reward! First, we must pick a reward <select reward>!" The researcher randomly selected the class' reward from a jar and either delivered it to the class immediately or asked the teacher to deliver the reward when applicable (e.g., 15 mins of free time after recess).

If the contingency requirement was not met, the researcher said, "Unfortunately, today you did not take more steps, but we will play this game on <specify the day>. You can try again to earn the reward then!" The researcher did not select a reward from the reward jar and encouraged them to try again next time.

Interdependent Group Contingency

The researcher referred to the IGC as the blue game when speaking to participants and teachers. During the presession period, the researcher told the class that everyone must achieve the step goal to receive the reward. Before the first session, the researcher said:

Hello everyone! Today we're going to play a new game! Today's game is called the blue game and I'm going to explain how it works. During this game everyone's going to wear a blue armband over their coat. If everyone tries their best and takes more steps during recess than before, everyone will get a reward! If some people don't take more steps, everyone will have to try again next time to get a reward. You can try to take more steps by playing a game together like soccer or tag or running during recess. After recess, I'll pull the name of the reward from a jar. It can change each time.

Everyone's going to wear their pedometers on their left hip for the whole recess like before. Don't open the case, take it off, or shake it because it'll stop working. If you don't want to play the game anymore, just come to me during recess and put your pedometer in the blue bin or give it to me when recess is done. Any questions?

Before each subsequent session, the researcher said:

Hi everyone! We are going to play the blue game again today during recess. If everyone takes more steps, everyone will get a reward. Remember, if you don't want to play the game at any point you can let me know. You won't get in trouble. And remember you all have to wear your pedometers properly and I'll hand out your blue armbands! Does anyone have any questions? Have a great recess!

Dependent Group Contingency

The researcher referred to the DGC as the red game when speaking to participants and teachers. During the presession period, the researcher randomly selected a pedometer number from the jar that contained slips of paper with the pedometer numbers of all participants present that session; the selected participant served as the hero for that session. The researcher did not identify the hero to the class or anyone outside of the research team. The same participant did not

serve as the hero for two consecutive sessions. The first time this condition was run, the researcher said:

> Hello everyone! Today we're going to play a new game! Today's game is called the red game and I'm going to explain how it works. During this game, everyone is going to wear a red armband over their coat. To play this game, first I'm going to pull a pedometer number to see who our class hero will be this recess <pull number> but I'm not going to tell you who our class hero is. If the hero tries their best and takes more steps than before, everyone will get a reward! If they don't reach their goal, you'll have to try again next time to get a reward. You can try to take more steps by playing a game together like soccer or tag or running during recess. After recess I'll pull the name of the reward from a jar. It can change each time.
>
> Everyone's going to wear their pedometers on their left hip for the whole recess like before. Don't open the case, take it off, or shake it because it'll stop working. If you don't want to play the game anymore just come to me during recess and put your pedometer in the blue bin or give it to me when recess is done. Any questions?

Before each subsequent session, the researcher said:

> Hi everyone! We are going to play the red game again today during recess. Today we have a secret hero. If they take more steps, everyone will get a reward. Remember, if you don't want to play the game at any point you can let me know. You won't get in trouble. And remember you all have to wear your pedometers properly and I'll hand out your red armbands! Does anyone have any questions? Have a great recess!

Social Validity

Due to COVID-19, we changed the questionnaire delivery method from in-person paper copies to online submissions through Qualtrics Survey Software. Although it was our initial plan, we were not able to acquire the necessary consent to conduct the student survey online. We asked teachers to complete the anonymous online social validity questionnaire (Appendix G) after data collection stopped.

The teacher questionnaire consisted of four sections. The first section included three closed-ended questions that asked teachers to select which group contingency (a) increased participant physical activity, (b) encouraged the most participant involvement, and (c) would be feasible for teachers to implement. The second and third sections included six identical questions on a 5-point rating scale ranging from 1 (strongly disagree) to 5 (strongly agree) related to the IGC and the DGC, respectively. We asked teachers to rate the extent to which each group contingency (a) improved participant physical activity level, (b) increased participant engagement and enjoyment, (c) was disruptive, (b) was simple to implement, and (c) was feasible to implement. We also asked teachers to rate whether they would like to be trained to implement each group contingency. The fourth section included one open-ended question in which we asked teachers to provide any additional feedback or comments related to any aspect of this study.

Results

Step Count Analyses

Figure 1 (top panel) depicts the class mean steps per minute for Class A. During baseline, we observed a moderate level of class mean steps per minute (M = 71; range, 68 to 74). During the group contingency comparison phase, we observed a 35% increase in the class mean steps

per minute in the IGC condition relative to baseline with a class average of 96 steps per min (range, 73 to 128). We observed a 28% increase in the class mean steps per minute in the DGC condition relative to baseline with a class average of 91 steps per min (range, 70 to 131). Despite the overall larger increase in class mean steps per minute observed in the IGC condition, participants in Class A never met the contingency requirement or received a reward in the IGC condition, whereas they met the contingency requirement and received a reward during 78% of DGC condition sessions.

Figure 1 (bottom panel) depicts the class mean steps per minute for Class B. During baseline, we observed a moderate level of class mean steps per minute (*M* = 63; range, 53 to 76). During the group contingency comparison phase, we observed a 30% increase in the class mean steps per minute in the IGC condition relative to baseline with a class average of 82 steps per min (range, 63 to 98). We observed a 24% increase in the class mean steps per minute in the DGC condition relative to baseline with a class average of 78 steps per min (range, 56 to 94). Despite the overall larger increase in class mean steps per minute observed in the IGC condition, participants in Class B only met the contingency requirement and received a reward during 14% of IGC condition sessions, whereas they met the contingency requirement and received a reward during 71% of DGC condition sessions.

Figure 2 depicts the percentage change in mean steps per minute from baseline for individual participants in Class A. Twenty-five of 28 (89%) participants in Class A showed an increase in their percentage change mean steps per minute relative to baseline in both group contingencies. Eighteen of 28 (64%) participants showed a larger increase in the percentage change of mean steps per minute relative to baseline in the IGC condition (*M* = 53%; range, 18% to 126%) than the DGC condition (*M* = 34%; range, 3% to 122%). Seven of 28 (25%)

participants showed a larger increase in their percentage change of mean steps per minute relative to baseline in the DGC condition (*M* = 56%; range, 19% to 86%) than the IGC condition (*M* = 38%; range, 16% to 67%). Three of 28 (11%) participants either showed no difference or a decrease in their percentage change of mean steps per minute relative to baseline in both the IGC condition (*M* = -7%; range, -13% to 0%) and the DGC condition (*M* = -16%; range, -27% to -8%).

Figure 3 depicts the percentage change in mean steps per minute from baseline for individual participants in Class B. Seventeen of 21 (81%) participants in Class B showed an increased in their percentage change in mean steps per minute relative to baseline in both group contingencies. Fourteen of 21 (71%) participants showed a larger increase in percentage change mean steps per minute relative to baseline in the IGC condition (*M* = 73%; range, 2% to 231%) than the DGC condition (*M* = 51%; range, -9% to 201%). Four of 21 (19%) participants showed a larger increase in their percentage change mean steps per minute relative to baseline in the DGC condition (*M* = 26%; range, 5% to 46%) than the IGC condition (*M* = 5%; range, 2% to 11%). One participant (5%) showed the same percentage change in mean steps per minute relative to baseline in both conditions (82%). One of 21 (5%) participants decreased their mean steps per minute relative to baseline in both the IGC condition (-15%) and the DGC condition (-25%). One of 21 (5%) participants decreased their percentage change in mean steps per minute relative to baseline in the IGC condition (-3%) and did not participate in the DGC condition.

Side Effect Analyses

To assess the variables with which positive and negative statements may be more likely to occur, we assessed the extent to which these statements occurred given (a) the group

contingency in effect, (b) the period of the visit (presession or postsession), and (c) whether the contingency requirement was met and the participants earned a reward.

Figure 4 depicts the mean rate of positive and negative statements per minute across presession and postsession periods for Class A. During the presession period in baseline, we observed zero positive statements and a mean rate of 0.06 negative statements per min (range, 0 to 0.18). During the presession period in the IGC condition, we observed a lower mean rate of positive statements (*M* = 0.02; range, 0 to 0.11) than negative statements (*M* = 0.32; range, 0 to 0.62). During the presession period in the DGC condition, we observed a higher mean rate of positive statements (*M* = 0.13; range, 0 to 0.33) than negative statements (*M* = 0.05; range, 0 to 0.21). During the postsession period in the IGC condition, we observed a lower mean rate of positive statements (*M* = 0.02; range, 0 to 0.15) than negative statements (*M* = 1.17; range, 0 to 3.87). During the postsession period in the DGC condition, we observed a higher mean rate of positive statements (*M* = 0.90; range, 0 to 1.95) than negative statements (*M* = 0.70; range, 0 to 2.57).

Figure 5 depicts the mean rate of positive and negative statements per minute across presession and postsession periods for Class B. During the presession period in baseline, we observed zero positive statements and a mean rate of 0.12 negative statements per min (range, 0 to 0.23). During the presession period in the IGC condition, we observed a lower mean rate of positive statements (*M* = 0.02; range, 0 to 0.11) than negative statements (*M* = 0.19; range, 0 to 0.76). During the presession period in the DGC condition, we observed a lower mean rate of positive statements (*M* = 0.08; range, 0 to 0.33) than negative statements (*M* = 0.32; range, 0 to 0.91). During the postsession period in the IGC condition, we observed zero positive statements and a mean rate of 1.52 negative statements per min (range, 0 to 5.66). During the postsession

period in the DGC condition, we observed a higher mean rate of positive statements (*M* = 1.48; range, 0 to 3.40) than negative statements (*M* = 0.61; range, 0 to 1.71).

Figure 6 depicts the mean rate of positive and negative statements during the postsession period when participants in Class A did and did not meet the contingency requirement and earned the reward. We observed a higher mean rate of positive (*M* = 1.15; range, 0.25 to 1.95) than negative (*M* = 0.80; range, 0 to 2.57) statements when the class earned the reward during the DGC condition. We observed a lower mean rate of positive (*M* = 0.02; range, 0 to 0.15) than negative (*M* = 1.17; range, 0 to 3.87) statements when the class did not earn the reward during the IGC condition. We did not observe positive statements but did observe negative statements (*M* = 0.33; range, 0 to 0.65) when the class did not earn the reward during the DGC condition.

Figure 7 depicts the mean rate of positive and negative statements during the postsession period when participants in Class B did and did not meet the contingency requirement and earned the reward. We did not observe any positive or negative statements when the class did earn the reward during the IGC condition. We observed a higher mean rate of positive (*M* = 1.77; range, 0.28 to 3.4) than negative (*M* = 0.86; range, 0 to 1.71) statements when the class earned the reward during the DGC condition. We did not observe positive statements but did observe negative statements (*M* = 1.65; range, 0 to 5.66) when the class did not earn the reward during the IGC condition. We did not observe any positive or negative statements when the class did not earn the reward during the DGC condition.

Social Validity Questionnaire

Table 2 depicts the results of Sections 1 to 3 of the anonymous teacher social validity questionnaire. We excluded responses to Section 4 from the table because it involved an open-ended question asking teachers to provide any additional feedback or comments related to any

aspect of this study. In Section 1, both teachers stated that the IGC got the most students involved. One teacher stated that the IGC increased more students' physical activity and that she would rather implement it than the DGC. Conversely, the other teacher stated that the DGC increased more students' physical activity and that she would rather implement it than the IGC.

In Sections 2 and 3, both teachers stated that both group contingencies increased student physical activity and enjoyment, but that the IGC (M = 5) was better than the DGC (M = 4.25; range, 4 to 4.5) across these areas. One teacher agreed that both group contingencies were disruptive. The other teacher disagreed that the IGC was disruptive (M = 3.25; range, 2.5 to 4) and neither agreed nor disagreed that the DGC was disruptive (M = 3.75; range, 3.5 to 4). Both teachers stated that the IGC was simpler (M = 5) to implement than the DGC (M = 4.25; range, 4 to 4.5). Although both teachers found both group contingencies to be effective and simple to implement, they did not express interest in receiving training on (M = 3.5; range, 3 to 4) or implementing (M = 3.25; range, 3 to 3.5) either group contingency in their class. In fact, on the open-ended question in the questionnaire (Section 4), one teacher expressed that, "Although I really enjoyed the concepts of the games, I am not sure if teachers would be interested in implementing [either group contingency] in the classroom on a regular basis, simply due to all the other requirements in our day."

Discussion

This is the first study to compare the effectiveness of the interdependent and dependent group contingencies on the amount of physical activity students engaged in during recess. We obtained three noteworthy findings in this study. First, both the IGC and DGC effectively increased participants' physical activity levels. Second, the IGC appeared to be slightly more effective than the DGC at increasing physical activity at the class-wide and individual levels of

analyses. Finally, participants in both classes engaged in higher rates of positive statements in the DGC condition and higher rates of negative statements in the IGC condition.

Our finding that both group contingencies produced an increase in class mean steps per minute is similar to those of previous researchers who found that the IGC (Foote et al., 2017; Galbraith & Normand, 2017; Kuhl et al., 2015; Normand & Burji, 2020) and the DGC (Vidoni et al., 2012; Vidoni et al., 2014) increased students' physical activity at school. However, we only observed small changes in class mean steps per minute from baseline in both group contingencies. This small change could be due to our selected step goal. That is, we arranged individual step goals for participants that were only 5% higher than each individual participant's mean steps per minute during baseline. It is possible that if we set a higher step goal (e.g., 10% above participants' mean baseline levels), we would have obtained a larger increase in mean steps per minute in one or both group contingencies. In fact, previous researchers who used a higher step goal (i.e., approximately an 18% increase from mean baseline levels) obtained a larger difference in mean steps per minute between baseline and the intervention phase (Kuhl et al., 2015) compared to those who used a relatively lower step goal (i.e., 5% increase from mean baseline levels; Kang & Brinthaupt, 2009). While previous researchers recommended arranging step goals that range from a 5%-10% increase from mean baseline levels, we selected 5% to ensure that the step goal was achievable and that participants would receive the reward. In fact, every participant met their step goal at least once in each group contingency, except for one participant in Class B who never met their step goal during the DGC condition. This suggests that for the vast majority of participants, the step goal was achievable and that it may have been possible for us to select a higher step goal. Future researchers may consider starting with a relatively lower step goal (e.g., 5% increase from mean baseline levels) then systematically

increasing the step goal throughout the phase to (a) ensure that participants first contact the contingency and (b) further increase the likelihood that participants contact the benefits of higher levels of physical activity. Future researchers may also consider conducting a parametric analysis to assess the effects of different step goals on physical activity and any concomitant side effects, such as positive and negative statements, and cooperative behaviour.

Although both group contingencies increased the overall class mean steps per minute for both classes, the IGC was slightly more effective at increasing physical activity from baseline (35% and 30% increase) than the DGC (28% and 24% increase) for Class A and B, respectively. However, we observed two noteworthy patterns of responding. First, toward the end of the group contingency comparison phase in Class B, we observed a decreasing trend in class mean steps per minute in the IGC condition and an increasing trend in class mean steps per minute in the DGC condition. We observed a similar, although much less prominent, increasing trend in the DGC condition in Class A. This might suggest that, after repeated exposure to each group contingency, the DGC may have become equally as effective for Class A and more effective for Class B than the IGC. However, without additional data, this remains an empirical question.

Second, when reviewing the difference in the mean steps per minute across the entire group contingency comparison phase, we found that the average class mean steps per minute did not drastically differ between the IGC and DGC conditions (difference of 5 mean steps per minute and 4 mean steps per minute in Class A and B, respectively). Therefore, we wanted to determine whether the (a) increase in mean steps per minute observed in both group contingencies from baseline and (b) difference between the IGC and DGC conditions were clinically and socially significant. Because physical activity is typically classified according to three levels of intensity: low, moderate, and vigorous, we wanted to determine if the

aforementioned improvements would translate into a change in level of intensity. Therefore, we reviewed the activities that the WHO (2020) and US Department of Health and Human Services (1999) classified as low, moderate, and vigorous intensity and we cross-referenced any age-appropriate activities with the corresponding step-per-minute equivalent reported by Healthy Steps to Albany (2009). Then we compared those steps per minute values to the average class mean steps per minute for both our classes during baseline, the IGC condition, and the DGC condition. During baseline, the class mean steps per minute (M = 71 and 63 for Class A and B, respectively) corresponded to low-intensity physical activity, such as bowling or shopping. For both classes, during the group contingency comparison phase in both conditions, the class mean steps per minute (IGC: M = 96 and 82; DGC: M = 91 and 78 for Class A and B, respectively) corresponded to moderate-intensity physical activity, such as ice-skating, jumping on the trampoline, playing volleyball, or walking at an average speed. This suggests that even though the IGC produced a slightly higher step count per minute across the entire phase than the DGC, both group contingencies appear to have resulted in an increase in the intensity of the participants' physical activity. This increase in intensity is both clinically and socially significant in light of the WHO (2018) recommendation that children and youth should engage in a minimum of 60 min of moderate to vigorous physical activity daily.

We also observed three interesting patterns of responding during our analysis of the side effects. First, there was little difference between the mean rate of positive and negative statements during the presession period across all conditions and phases for both classes. Previous researchers have suggested that because participants are not told who did not meet the contingency requirement during the IGC or DGC with an unidentified hero, there might be fewer negative social consequences for those participants who did not meet the contingency

requirement (Heering & Wilder 2006; Kelshaw-Levering et al., 2000). Previous researchers have also stated that both of these group contingencies promote cooperative behaviour among participants (Hartman & Gresham, 2016; Heering & Wilder 2006; Kelshaw-Levering et al., 2000) because they must either work together, rely on each other, or both to meet the contingency requirement and receive the reward (Heering & Wilder 2006; Kelshaw-Levering et al., 2000). Although we obtained low rates of positive statements during the presession period, anecdotally, participants organized collaborative games and activities (e.g., tag, manhunt) to play during recess. Anecdotally, teachers also reported they observed class collaboration during recess among the participants. Our anecdotal observations appear to support previous researchers' suggestions that the IGC and DGC with an unidentified hero promote collaboration.

Second, during the postsession period, we observed a large difference between positive and negative statements across both group contingencies. That is, the DGC had higher mean rates of positive statements in Class A (M = 0.94) and Class B (M = 1.48), while the IGC had higher mean rates of negative statements in Class A (M = 1.76) and Class B (M = 2.00). While this might seem to suggest that the DGC produced more favourable side effects than the IGC, previous researchers have discussed the possibility that the rate of positive and negative statements may be influenced by the amount of reinforcement associated with a given group contingency (Payne et al., 2017). Because participants in Class A and B received the reward more frequently during the DGC condition (M = 78% and M = 71%, respectively) than the IGC condition (M = 0% and M = 14%, respectively), it is possible that the different amounts of rewards obtained across these group contingencies influenced the rate of negative statements more so than the contingencies arranged in the IGC and DGC.

Therefore, we analyzed the mean rate of positive and negative statements in the postsession period when participants met the contingency requirement and earned the reward and when they did not. Irrespective of the group contingency in effect, the mean rate of positive statements was higher when participants earned the reward (M = 1.15 and M = 1.47) and the mean rate of negative statements was higher when they did not earned the reward (M = 0.98 and M = 1.24) for Class A and B, respectively. These findings suggest that earning the reward was more influential for producing positive statements than the contingencies arranged in the IGC and DGC. Interestingly, we also observed relatively high rates of negative statements when participants met the contingency requirement and earned the reward across both group contingencies in both Class A (M = 0.80) and Class B (M = 0.71). Anecdotally, these negative statements tended to relate to the participants' preference for the randomly selected reward (e.g., "Aww, why did we get gum? I wanted hot chocolate," "Not the pencils!"). Because we did not collect data on the specific types of positive and negative statements, we cannot say with certainty that all negative statements made after the researcher announced the class reward were of this nature. Therefore, future researchers may consider collecting data on separate topographies of positive and negative statements to allow for a more fine-grained analysis.

Limitations

Our findings should be interpreted within the context of four additional limitations. First, due to the stay-at-home order imposed by the government in response to the COVID-19 pandemic, we only included two classes in our multiple baseline design, whereas best practice recommends at least three replications of the effects of the independent variable. Despite this limitation, we used a concurrent multiple baseline design, which provides a greater degree of experimental control than a nonconcurrent multiple baseline design. This is because it also

controls for historical threat to internal validity and demonstrates the verification of the intervention's effect in addition to the maturation threats to internal validity and the demonstration of prediction and replication provided by the nonconcurrent multiple baseline design (Carr, 2005). Further, we could have strengthened our experimental control by including baseline probes to allow us to detect multiple treatment interference. That said, we incorporated several strategies to mitigate the likelihood of this threat to internal validity. That is, we included discriminative stimuli (different coloured armbands) that were associated with both group contingencies and we told the participants which group contingency was in effect before each session. Despite this, future researchers should compare the effects of these group contingencies across at least three classes and may also consider including baseline probes to further enhance the experimental control.

Second, we did not collect postsession period side effect data during baseline, which precluded us from comparing side effects obtained during the group contingency comparison phase to those obtained in baseline. This is because our postsession period began once the researcher returned to the classroom to announce whether the class met the contingency requirement and if the class received a reward or not. During baseline, the researcher did not return to the classroom to provide feedback to the class. Therefore, future researchers may consider programming a similar postsession period during baseline to allow for a more complete analysis of side effects across phases.

Third, we were not able to collect social validity data from participants because the schools closed due to the COVID-19 pandemic; our request to obtain electronic social validity data from participants was denied by the school board's institutional review board. However, we were able to collect anonymous teacher social validity data electronically. Because these

questionnaires were anonymous, we were not able to make any comparisons between the teachers' ratings to their corresponding classes' performance. Therefore, future researchers may consider collecting (a) participant social validity data and (b) confidential rather than anonymous social validity data from teachers to allow researchers to make direct comparisons between a specific classes' change in physical activity and their teachers' corresponding ratings for each group contingency.

Finally, we did not assess generalization or maintenance of the treatment effects. Future researchers may consider assessing the extent to which generalization to other students in the school occurs. In fact, we observed that students from other classes took part in the games that participants arranged during recess, suggesting that schools might be able to increase physical activity of non-participating students by simply arranging a group contingency in one class. Further, future researchers may consider assessing whether participants' physical activity increased during other recess periods throughout the day. Due to the school closures, we were not able to collect maintenance data to determine if physical activity levels persisted over time. Therefore, future researchers should systematically assess the extent to which the treatment effects maintain over time.

References

Alric, J. M., Bray, M. A., Kehle, T. J., Chafouleas, S. M., & Theodore, L. A. (2007). A comparison of independent, interdependent, and dependent group contingencies with randomized reinforcers to increase reading fluency. *Canadian Journal of Psychology, 22*(1), 81-93. https://doi.org/10.1177/0829573507301254

Axelrod, S. (1973). Comparison of individual and group contingencies in two special classes. *Behavior Therapy, 4*(1), 83-90. https://doi.org/10.1016/S0005-7894(73)80076-0

Barfield, J. P., Row, D. A., & Michael, T. J. (2004). Interinstrument consistency of the Yamax Digi-Walker pedometer in elementary school-aged children. *Measurement in Physical Education and Exercise Science, 8*(2), 109-116. https://doi.org/10.1207/s15327841mpee0802_5

Barrish, H. H., Saunders, M., & Wolf, M. M. (1969). Good behavior game: Effects of individual contingencies for group consequences on disruptive behavior in a classroom. *Journal of Applied Behavior Analysis, 2*(2), 119-124. https://doi.org/10.1901/jaba.1969.2-119

Beeks, A., & Graves Jr., S. (2016). The effects of the mystery motivator intervention in an urban classroom. *School Psychology Forum: Research in Practice, 10*(2), 142-156.

Brantley, D. C., & Webster, R. E. (1993). Use of an independent group contingency management system in a regular classroom setting. *Psychology in the Schools, 30*(1), 60-66. https://doi.org/10.1002/1520-6807(199301)30:1<60::AID-PITS2310300110>3.0.CO;2-X

Briesch, A. M., Hemphill, E., & Daniels, B. (2013). Check your SLANT: Adapting self-management for use as a class-wide intervention. *School Psychology Forum: Research in Practice, 7*(2), 29-39.

Brown, D. C., & Reschly, D. (1974). The modification of classroom asocial behaviors: Individual vs group incentives. *School Applications of Learning Theory, 6*(4), 42-49.

Brown, D., Reschly, D., & Sabers, D. (1974). Using group contingencies with punishment and positive reinforcement to modify aggressive behaviors in a Head Start classroom. *The Psychological Record, 24*(4), 491-496.

Bulla, A. J., & Frieder, J. E. (2018). Self-management as a class-wide intervention: An evaluation of the "self & match" system embedded within a dependent group contingency. *Psychology in the Schools, 55*(3), 305-322. https://doi.org/10.1002/pits.22109

Bushell, D., Wrobel, P. A., & Michaelis, M. L. (1968). Applying "group" contingencies to the classroom study behavior of preschool children. *Journal of Applied Behavior Analysis, 1*(1), 55-61. https://doi.org/10.1901/jaba.1968.1-55

Caldarella, P., Williams, L., Hansen, B. D., & Wills, H. (2015). Managing student behavior with class-wide function-related intervention teams: An observational study in early elementary classrooms. *Early Childhood Education Journal, 43*(5), 357-365. https://doi.org/10.1007/s10643-014-0664-3

Campbell, S., & Skinner, C. H. (2004). Combining explicit timing with an interdependent group contingency program to decrease transition times: An investigation of the timely transitions game. *Journal of Applied School Psychology, 20*(2), 11-27. https://doi.org/10.1300/J370v20n02_02

Cariveau, T., & Kodak, T. (2017). Programming a randomized dependent group contingency and common stimuli to promote durable behavior change. *Journal of Applied Behavior Analysis, 50*(1), 121-133. https://doi.org/10.1002/jaba.352

Carr, J. E. (2005). Recommendations for reporting multiple-baseline designs across participants. *Behavioral Interventions, 20*(3), 219-224. https://doi.org/10.1002/bin.191

Centers for Disease Control and Prevention (2018). *CDC Healthy schools: Physical activity facts*. https://www.cdc.gov/healthyschools/physicalactivity/facts.htm

Cheatham, J. M., Ozga, J. E., St. Peter, C. C., Mesches, G. A., & Owsiany, J. M. (2017). Increasing class participation in college classrooms with the good behavior game. *Journal of Behavior Education, 26*(3), 277-292. https://doi.org/10.1007/s10864-017-9266-7

Christ, T. J., & Christ, J. A. (2006). Application of an interdependent group contingency mediated by an automated feedback device: An intervention across three high school classrooms. *School Psychology Review, 35*(1), 78-90.

Clair, E. B., Bahr, M. W., Quach, H. L., & LeDuc, J. D. (2018). The positive plus program: Affirmative classroom management to improve student behavior. *Behavioral Interventions, 33*(3), 221-236. https://doi.org/10.1002/bin.1632

Collins, T. A., Hawkins, R. O., Flowers, E. M., Kalra, H. D., Richard, J., & Haas, L. E. (2017). Behavior bingo: The effects of a culturally relevant group contingency intervention for students with EBD. *Psychology Schools, 55*(1), 63-75. https://doi.org/10.1002/pits.22091

Cooper, J. O., Heron, T. E., & Heward, W. L. (2007). Applied behavior analysis (2nd ed). Pearson.

Crouch P. L., Gresham, F. M., & Wright, W. R. (1985). Interdependent and independent group contingencies with immediate and delayed reinforcement for controlling classroom behavior. *Journal of School Psychology, 23*(2), 177-187. https://doi.org/10.1016/0022-4405(85)90008-1

Dart, E. H., Radley, K. C., Battaglia, A. A., Dadakhodjaeva, K., Bates, K. E., & Wright, S. J. (2016). The classroom password: a class-wide intervention to increase academic engagement. *Psychology in Schools, 53*(4), 416-431. https://doi.org/10.1002/pits.21911

Denune, H., Hawkins, R., Donovan, L., McCoy, D., Hall, L., & Moeder, A. (2015). Combining self-monitoring and an interdependent group contingency to improve the behavior of sixth graders with EBD. *Psychology in the Schools, 52*(6), 562-577. https://doi-org.proxy.library.brocku.ca/10.1002/pits.21846

Deshais, M. A., & Fisher, A. B., & Kahng, S. W. (2019). A comparison of group contingencies on academic compliance. *Journal of Applied Behavior Analysis, 52*(1), 116-131. https://doi.org/10.1002/jaba.505

Deshais, M. A., Fisher, A. B., & Kahng, S. W. (2018). A preliminary investigation of a randomized dependent group contingency for hallway transitions. *Education and Treatment of Children, 41*(1), 49-64. https://doi.org/10.1353/etc.2018.0002

Donaldson, J. M., Matter, A. L., & Wiskow, K. M. (2018). Feasibility of and teacher preference for student-led implementation of the good behavior game in early elementary classrooms. *Journal of Applied Behavior Analysis, 51*(1), 118-129. https://doi.org/10.1002/jaba.432

Donaldson, J. M., Vollmer, T. R., Krous, T., Downs, S., & Berard, K. P. (2011). An evaluation of the good behavior game in kindergarten classrooms. *Journal of Applied Behavior Analysis, 44*(3), 605-609. https://doi.org/10.1901/jaba.2011.44-605

Ellery, M. D., Blampied, N. M., & Black, W. A. (1975). Reduction of disruptive behaviour in the classroom: Group and individual reinforcement contingencies compared. *New Zealand Journal of Educational Studies, 10*, 59-65.

Ennis, C. R., Blair, K. C., & George, H. P. (2016). An evaluation of group contingency interventions: The role of teacher preference. *Journal of Positive Behavior Interventions, 18*(1), 17-28. https://doi.org/10.1177/1098300715577663

Fedewa, A. L., & Ahn, S. (2011). The effects of physical activity and physical fitness on children's achievement and cognitive outcomes: A meta-analysis. *Research Quarterly for Exercise and Sport, 82*(3), 521-535. https://doi.org/10.1080/02701367.2011.10599785

Foley, E. A., Dozier, C. L., & Lessor, A. L. (2019). Comparison of components of the good behavior game in a preschool classroom. *Journal of Applied Behavior Analysis, 52*(1), 84-104. https://doi.org/10.1002/jaba.506

Foote, C., Bray, M. A., Kehle, T. J., VanHeest, J. L., Gelbar, N. W., Byer-Alcorace, G., . . . & DeBiase, E. (2017). Interdependent group contingency to promote physical activity in children. *Canadian Journal of School Psychology, 32*(2), 144-161. https://doi.org/10.1177/0829573516644901

Galbraith, L. A., & Normand, M. P. (2017). Step it up! Using the good behavior game to increase physical activity with elementary school students at recess. *Journal of Applied Behavior Analysis, 50*(4), 856-860. https://doi.org/10.1002/jaba.402

Gamble A., & Strain, P. S. (1979). The effects of dependent and interdependent group contingencies on socially appropriate responses in classes for emotionally handicapped children. *Psychology in the Schools, 16*(2), 253-260. https://doi.org/10.1002/1520-6807(197904)16:2<253::AID-PITS2310160216>3.0.CO;2-S

Goldberg, R., & Shapiro, E. S. (1995). In-vivo rating of treatment acceptability by children: Effects of probability instruction on student's spelling performance under group

contingency conditions. *Journal of Behavioral Education, 5*(4), 415-432. https://doi.org/10.1007/BF02114541

Grandy, G. S., Madsen, C. H., De Mersseman, L. M. (1973). The effects of individual and interdependent contingencies on inappropriate classroom behavior. *Psychology in the Schools, 10*(4), 488-493.

Gresham, F. M., & Gresham, G. N., (1982). Interdependent, dependent, and independent group contingencies for controlling disruptive behavior. *The Journal of Special Education, 16*(1), 101-110. https://doi.org/10.1177/002246698201600110

Gross, T. J., Duhon, G. J., Shutte, G., & Rowland, J. E. (2016). Comparison of group-oriented contingences for addition fluency. *Contemporary School Psychology, 20*(2), 130-141. https://doi.org/10.1007/s40688-015-0054-x

Groves, E. A., & Austin, J. L. (2017). An evaluation of interdependent and independent group contingencies during the good behavior game. *Journal of Applied Behavior Analysis, 50*(3), 552-566. https://doi.org/10.1002/jaba.393

Hamblin, R. L., Hathaway, C., & Wodarski, J. S. (1971). Group contingencies, peer tutoring and accelerating academic achievement. *School Psychology Review, 2*(2), 36-41. https://doi.org/10.1080/02796015.1973.12086068

Hansen, S. D., & Lignugaris/Kraft, B. (2005). Effects of a dependent group contingency on the verbal interactions of middle school students with emotional disturbance. *Behavioral Disorders, 30*(2), 170-184. https://doi.org/10.1177/019874290503000204

Hartman, K., & Gresham, F. (2016). Differential effectiveness of interdependent and dependent group contingencies in reducing disruptive classroom behavior. *Journal of Applied School Psychology, 32*(1), 1-23. https://doi.org/10.1080/15377903.2015.1056922

Hawkins, R. O., Haydon, T., Denune, H., Larking, W., & Fite, N. (2015). Improving the transition behavior of high school students with emotional behavioral disorders using a randomized interdependent group contingency. *School Psychology Review*, *44*(2), 208-223. https://doi.org/10.17105/spr-14-0020.1

Hawkins, R. O., Haydon, T., McCoy, D., & Howard, A. (2017). Effects of an interdependent group contingency on the transition behavior of middle school students with emotional and behavioral disorders. *School Psychology Quarterly*, *32*(2), 282-289. http://dx.doi.org.proxy.library.brocku.ca/10.1037/spq0000202

Healthy Steps to Albany. (2009). *Convert your exercise minutes into steps.* https://www.cwu.edu/hr/sites/cts.cwu.edu.hr/files/documents/conversion_chart.pdf

Heart and Stroke Foundation (2017). *Schools and physical activity.* https://www.heartandstroke.ca/-/media/pdf-files/canada/2017-position-statements/schoolsand-physical-activity-ps-eng.ashx?la=en&hash=580646080271E0B23D828BD7730FCA2C6EF7ECC1

Heering, P. W., & Wilder, D. A. (2006). The use of dependent group contingencies to increase on-task behavior in two general education classrooms. *Education and Treatment of Children*, *29*(3), 459-468. https://doi.org/10.1080/08870440903318119

Herman, S. H. & Tramontana, J. T. (1971). Instructions and group versus individual reinforcement in modifying disruptive group behavior. *Journal of Applied Behavior Analysis*, *4*(2), 113-119. https://doi.org/10.1901/jaba.1971.4-113

Hernan, C. J., Collins, T. A., Morrison, J. Q., & Kroeger, S. D. (2019). Decreasing inappropriate use of mobile devices in urban high school classrooms: Comparing an antecedent

intervention with and without the good behavior game. *Behavior Modification, 43*(3), 439-463. https://doi.org/10.1177/0145445518764343

Jacobs, J. F. (1974). Group contingent reinforcement with slow learning, culturally deprived children. *The Journal of Experimental Education, 43*(2), 40-44.

Jones, M. E., Allday, R. A., & Givens, A. (2019). Reducing adolescent cell phone usage using an interdependent group contingency. *Journal of Applied Behavior Analysis, 52*(2), 386-393. https://doi.org/10.1002/jaba.538

Jones, M. E., Boon, R. T., Fore, C., & Bender, W. N. (2008). Our mystery hero! A group contingency intervention for reducing verbally disrespectful behaviors. *Learning Disabilities, 15*(2), 61-69.

Kang, M., & Brinthaupt, T. M. (2009). Effects of group- and individual-based step goals on children's physical activity levels in school. *Pediatric Exercise Science, 21*(2), 148-158. https://doi.org/10.1123/pes.21.2.148

Kelshaw-Levering, K., Sterling-Turner, H. E., Henry, J. R., & Skinner, C. H. (2000). Randomized interdependent group contingencies: Group reinforcement with a twist. *Psychology in the Schools, 37*(6), 523-533. https://doi.org/10.1002/1520-6807(200011)37:6<523::AID-PITS5>3.0.CO;2-W

Kohler, F. W., Strain, P. S., Maretsky, S., & DeCesare, L. (1990). Promoting positive supportive interactions between preschoolers: An analysis of group-oriented contingencies. *Journal of Early Intervention, 14*(4), 327-341. https://doi.org/10.1177/105381519001400404

Kuhl, S., Rudrud, E. H., Witts, B. N., & Schulze, K. A. (2015). Classroom-based interdependent group contingencies increase children's physical activity. *Journal of Applied Behavior Analysis, 48*(3), 602-612. https://doi.org/10.1002/jaba.219

Leflot, G., van Lier, P. A. C., Onghena, P., & Colpin, H. (2013). The role of children's on-task behavior in the prevention of aggressive behavior development and peer rejection: A randomized controlled study of the good behavior game in Belgian elementary classrooms. *Journal of School Psychology, 51*(2), 187-199. https://doi.org/10.1016/j.jsp.2012.12.006

Levin, L. (1973). A comparison of individual and group contingencies with third and fourth grade children. *University of Maryland Counseling and Personnel Services Journal, 3*(1), 22-24.

Litow, L., & Pumroy, D. K. (1975). Brief review of classroom group-oriented contingencies. *Journal of Applied Behavior Analysis, 8*(3), 341-347. https://doi.org/10.1901/jaba.1975.8-341

Little, S. G., Akin-Little, A., & Newman-Eig, L. M. (2010). Effects of homework completion and accuracy of varied and constant reinforcement within an interdependent group contingency system. *Journal of Applied School Psychology, 26(*2), 115-131. https://doi.org/10.1080/15377900903471989

Lloyd, J. W., Eberhardt, M. J., & Drake, G. P. (1996). Group versus individual reinforcement contingencies within the context of group study conditions. *Journal of Applied Behavior Analysis, 29*(2), 189-200. https://doi.org /10.1901/jaba.1996.29-189

Long, J. D., & Williams, R. L. (1973). The comparative effectiveness of group and individually contingent free time with inner-city junior high school students. *Journal of Applied Behavior Analysis, 6*(3), 465-474. https://doi.org/10.1901/jaba.1973.6-465

Lynch, A., Theodore, L. A., Bray, M. A., & Kehle, T. J. (2009). A comparison of group-oriented contingencies and randomized reinforcers to improve homework completion and accuracy for students with disabilities. *School Psychology Review, 38*(3), 307-324.

Lum, J. D. K., Radley, K. C., & Tingstrom, D. H., Dufrene, B. A., Olmi, D. J., & Wright, S. J. (2019). Tootling with a randomized independent group contingency to improve high school classwide behavior. *Journal of Positive Behavior Interventions, 21*(2), 93-105. https://doi.org/10.1177/1098300718792663

McGoey, K. E., Schneider, D. L., Prodan, T., & Tankersley, M. (2010). Classwide intervention to manage disruptive behavior in the kindergarten classroom. *Journal of Applied School Psychology, 26*(3), 247-261. https://doi.org/10.1080/15377903.2010.495916

McLaughlin, T. F. (1981). The effects of individual and group contingencies on reading performance of special education students. *Contemporary Educational Psychology, 6*(1), 76-79. https://doi.org/10.1016/0361-476X(81)90032-1

McLaughlin, T. F. (1982). A comparison of individual and group contingencies on spelling performance with special education students. *Child and Family Behavior Therapy, 4*(2), 1-10. https://doi.org/10.1300/J019v04n02_01

McReynolds, W. T., Gange, J. J., & Speltz, M. L. (1981). Effects of multiple individual and group operant contingencies on student performance. *Education and Treatment of Children, 4*(3), 227-241.

Nevin, A., Johnson, D. W., & Johnson, R. (1982). Effects of group and individual contingencies on academic performance and social relations of special needs students. *The Journal of Social Psychology, 116*(1), 41-59.

Normand, M. P., & Burji, C. (2020). Using the Step it Up! Game to increase physical activity during physical-education classes. *Journal of Applied Behaviour Analysis, 53*(2), 1071-1079. https://doi.org/10.1002/jaba.624

Page, D. P., & Edwards, R. P. (1978). Behavior change strategies for reducing disruptive classroom behavior. *Psychology in the Schools, 15*(3), 413-418. https://doi.org/10.1002/1520-6807(197807)15:3<413::AID-PITS2310150320>3.0.CO;2-4

Payne, S. W., Dozier, C. L., Briggs, A. M., & Newquist, M. H. (2017). An analysis of group-oriented contingencies and associated side effects in preschool children. *Journal of Behavioral Education, 26*(1), 27-52. https://doi.org/10.1007/s10864-016-9255-2

Pennington, B., & McComas, J. J. (2017). Effects of the good behavior game across classroom contexts. *Journal of Applied Behavior Analysis, 50*(1), 176-180. https://doi.org/10.1002/jaba.357

Perline, I. H. & Levinsky, D. (1968). Controlling behavior in the severely retarded. *American Journal of Mental Deficiency, 73*(1), 74-78.

Pokorski, E. A., Barton, E. E., & Ledford, J. R. (2019). Assessing the differential effects of known and mystery rewards in a preschool-based group contingency. *Journal of Early Intervention, 41*(3), 256-275. https://doi.org/10.1177/1053815119841088

Popkin, J., & Skinner, C. H. (2003). Enhancing academic performance in a classroom serving students with serious emotional disturbance: Interdependent group contingencies with randomly selected components. *School Psychology Review, 32*(2), 282-295.

Rasberry, C. N., Lee, S. M., Robin, L., Laris, B. A., Russell, L. A., Coyle, K. K., & Nihiser, A. J. (2011). The association between school-based physical activity, including physical

education, and academic performance: A systematic review of the literature. *Preventive Medicine, 52*(1), 10-20. https://doi.org/10.1016/j.ypmed.2011.01.027

Reinhardt, D., Theodore, L. A., Bray, M., & Kehle, T. J. (2009). Improving homework accuracy: Interdependent group contingencies and randomized components. *Psychology in the Schools, 46*(5), 471-488 https://doi.org/10.1002/pits.20391

Ruedebusch, J. D. (1979). Increase of oral reading rate through the use of group and individually contingent free time. *Directive Teacher, 1*, 6-7.

Schanding, G. T., & Sterling-Turner, H. E. (2010). Use of the mystery motivator for a high school class. *Journal of Applied School Psychology*, *26*(1), 38-53. https://doi.org/10.1080/15377900903379448

Scott, K. C., Skinner, C. H., Moore, T. C., McCurdy, M., Ciancio, D., & Cihak, D. F. (2017). Evaluating and comparing the effects of group contingencies on mathematics accuracy in a first-grade classroom: Class average criteria versus unknown small-group average criteria. *School Psychology Review, 46*(3), 262-271. http://doi.org/10.17105/SPR-2017-0037.V46-3

Shapiro, E. S., & Goldberg, R. (1986). A comparison of group contingencies for increasing spelling performance among sixth grade students. *School Psychology Review, 15*(4), 546-557. https://doi.org/10.1080/02796015.1986.12085256

Speltz, M. L., Shimamura, J. W., & McReynolds, W. T. (1982). Procedural variations in group contingencies: Effects on children's academic and social behaviors. *Journal of Applied Behavior Analysis, 15*(4), 533-544. https://doi.org/10.1901/jaba.1982.15-533

Springboard to Active Schools (2019). *Integrate Classroom Physical Activity in Schools.* Centers for Disease Control and Prevention.

https://www.cdc.gov/healthyschools/physicalactivity/pdf/Classroom_PA_Data_Brief_CDC-Logo_FINAL_191106.pdf

Statistics Canada (2017). *Physical activity of Canadian children and youth.* https://www150.statcan.gc.ca/n1/pub/11-627-m/11-627-m2017034-eng.htm

Stewart, J. P., & McLaughlin, T. F. (1986). Effects of group and individual contingencies on reading performance with Native American junior high school students. *Techniques, 2*(2), 133-144.

Swain, J. J., Allard, G. B., & Holborn, S. W. (1982). The good toothbrushing game: A school-based dental hygiene program for increasing the toothbrushing effectiveness of children. *Journal of Applied Behavior Analysis, 15*(1), 171-176. https://doi.org/10.1901/jaba.1982.15-171

Theodore, L. A., Bray, M. A., Kehle, T. J., & Jenson, W. R. (2001). Randomization of Group Contingencies and Reinforcers to Reduce Classroom Disruptive Behavior. *Journal of School Psychology, 39*(3), 267-277. https://doi.org/10.1016/S0022-4405(01)00068-1

Theodore, L. A., Bray, M. A., & Kehle, T. J. (2004). A comparative study of group contingencies and randomized reinforcers to reduce disruptive classroom behavior. *School Psychology Quarterly, 19*(3), 253-271. https://doi.org/10.1521/scpq.19.3.253.40280

Trevino-Maack, S. I., Kamps, D., & Wills, H. (2015). A group contingency plus self-management intervention targeting at-risk secondary students' class-work and active engagement. *Remedial and Special Education, 36*(6), 347-360. https://doi.org/10.1177/0741932514561865

U.S. Department of Health and Human Services. (1999). *Promoting physical activity*. https://www.k-state.edu/paccats/Contents/PA/PDF/PA%20by%20Intensity.pdf

Vargo, K. K., & Backnell, K. (2019). An application of the group-oriented concurrent-chains arrangement. *Behavior Analysis in Practice, 12*(2), 310-319. https://doi.org/10.1007/s40617-018-00286-6

Vidoni, C., Azevedo, L., & Eberline, A. (2012). Effects of a group contingency strategy on middle school physical education students' heart rates. *European Physical Education Review, 18*(1), 78-96. https://doi.org/10.1177/1356336X11430652

Vidoni, C., Lee, C., & Azevedo, L. B. (2014). Fair play game: A group contingency strategy to increase students' active behaviours in physical education. *Early Child Development and Care, 184*(8), 1127-1141. https://doi.org/10.1080/03004430.2013.847834

Vidoni, C., & Ward, C. (2006). Effects of a dependent group-oriented contingency on middle school physical education students' fair play behaviors. *Journal of Behavioral Education, 15*(2), 81-92. https://doi.org/10.1007/s10864-006-9012-z

Williamson, B. D., Campbell-Whatley, G. D., & Lo, Y. (2009). Using a random dependent group contingency to increase on-task behaviors of high school students with high incidence disabilities. *Psychology in the Schools, 46*(10), 1074-1083. https://doi.org/10.1002/pits.20445

Williamson, D. A., Williamson, S. H., Watkins, P. C., & Hughes, H. H. (1992). Increasing cooperation among children using dependent group-oriented reinforcement contingencies. *Behavior Modification, 16*(3), 414-425. https://doi.org/10.1177/01454455920163007

Wodarski, J. S., Hamblin, R. L., Buckholdt, D. R., & Ferritor, D. E. (1972). The effects of low performance group and individual contingencies on cooperative behaviors exhibited by fifth graders. *The Psychological Record, 22*(3), 359-368. https://doi.org/10.1007/BF03394100

World Health Organization (2007). *WHO information series on school health.* https://www.who.int/school_youth_health/resources/information_series/FINAL%20Final.pdf

World Health Organization (2011). *Global recommendations on physical activity for health.* https://www.who.int/dietphysicalactivity/publications/physical-activity-recommendations-5-17years.pdf?ua=1

World Health Organization (2018). *Physical activity.* https://www.who.int/news-room/fact-sheets/detail/physical-activity

World Health Organization (2019). *Adolescent mental health.* https://www.who.int/news-room/fact-sheets/detail/adolescent-mental-health

World Health Organization (2020). *Global strategy on diet, physical activity and health.* https://www.who.int/dietphysicalactivity/physical_activity_intensity/en/

Table 1

Mean Rate of Statements per Minute Across Conditions and Periods

		Positive Statements		Negative Statements	
Condition	Period	(M)	(range)	(M)	(range)
		Class A			
Baseline	Presession	0	-	0.06	0-0.18
IGC	Presession	0.02	0-0.11	0.32	0-0.62
	Postsession	0.02	0-0.15	1.17	0-3.87
DGC	Presession	0.13	0-0.33	0.05	0-0.21
	Postsession	0.90	0-1.95	0.70	0-2.57
		Class B			
Baseline	Presession	0	-	0.12	0-0.23
IGC	Presession	0.02	0-0.11	0.19	0-0.76
	Postsession	0	-	1.52	0-5.66
DGC	Presession	0.08	0-0.33	0.32	0-0.91
	Postsession	1.48	0-3.40	0.61	0-1.71

Table 2

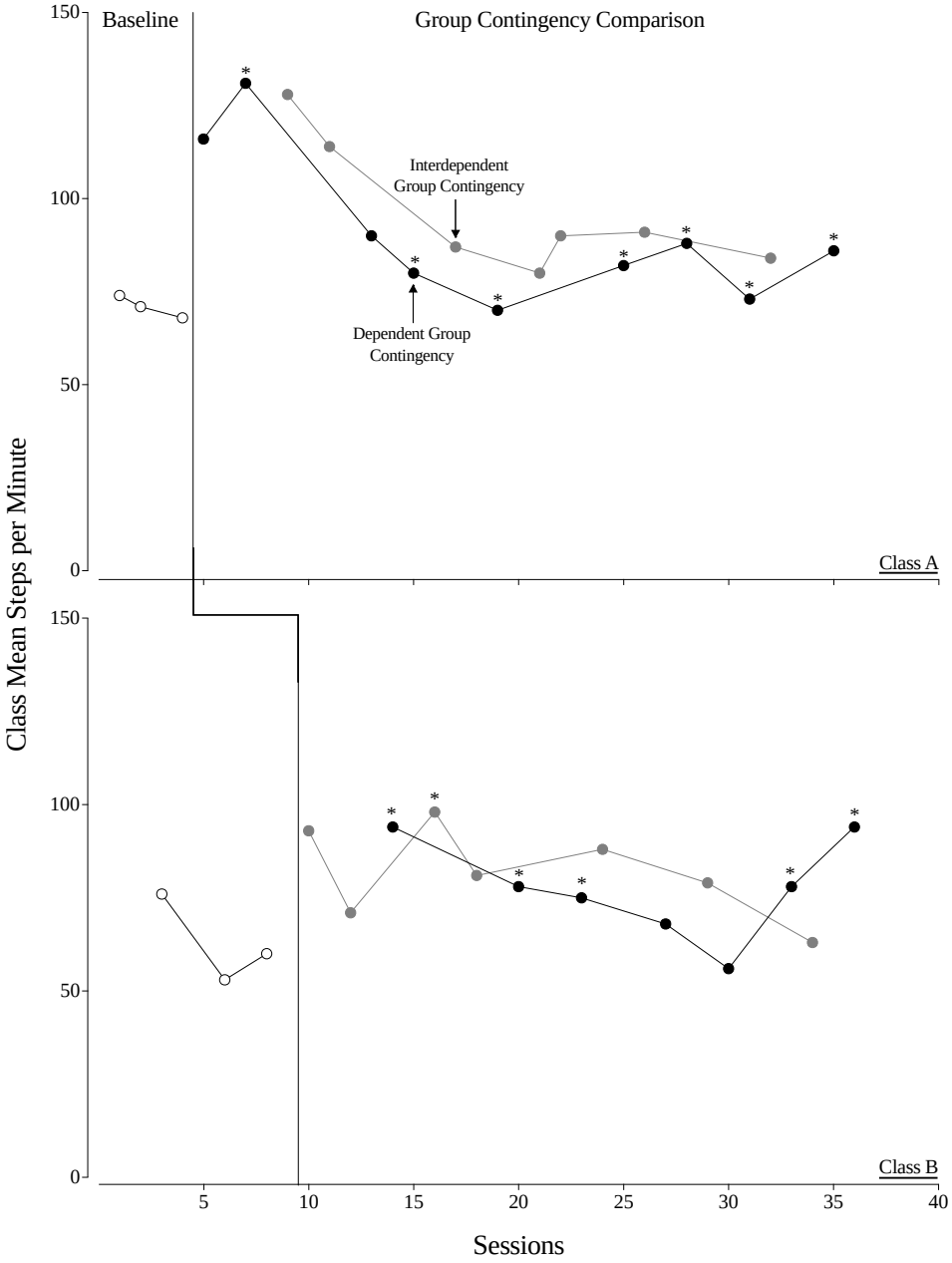
Teacher Social Validity Questionnaire

Section	Category	Questions	Teacher 1	Teacher 2
1	Comparison	Which game increased physical activity most in your class?	IGC	DGC
		Which game got most students involved?	IGC	IGC
		In the future, I would be most likely to implement.	IGC	DGC
2	IGC	This game seemed to increase physical activity for the entire class.	5	5
		The students enjoyed participating in this game.	5	5
		This game was disruptive before and after recess.	4	2.5
		This game seemed simple to implement.	5	5
		I would want to be trained and try implementing this game in the future.	3	4
		I think it would be feasible to implement this game in my class regularly.	3	3.5
3	DGC	This game seemed to increase physical activity for the entire class.	4	4.5
		The students enjoyed participating in this game.	4	4.5
		This game was disruptive before and after recess.	4	3.5
		This game seemed simple to implement.	4	4.5
		I would want to be trained and try implementing this game in the future.	3	4
		I think it would be feasible to implement this game in my class regularly.	3	3.5

Note. This table depicts the results of three of four sections of the teacher social validity questionnaire on a 5-point rating scale ranging from 1 (strongly disagree) to 5 (strongly agree).

Figure 1

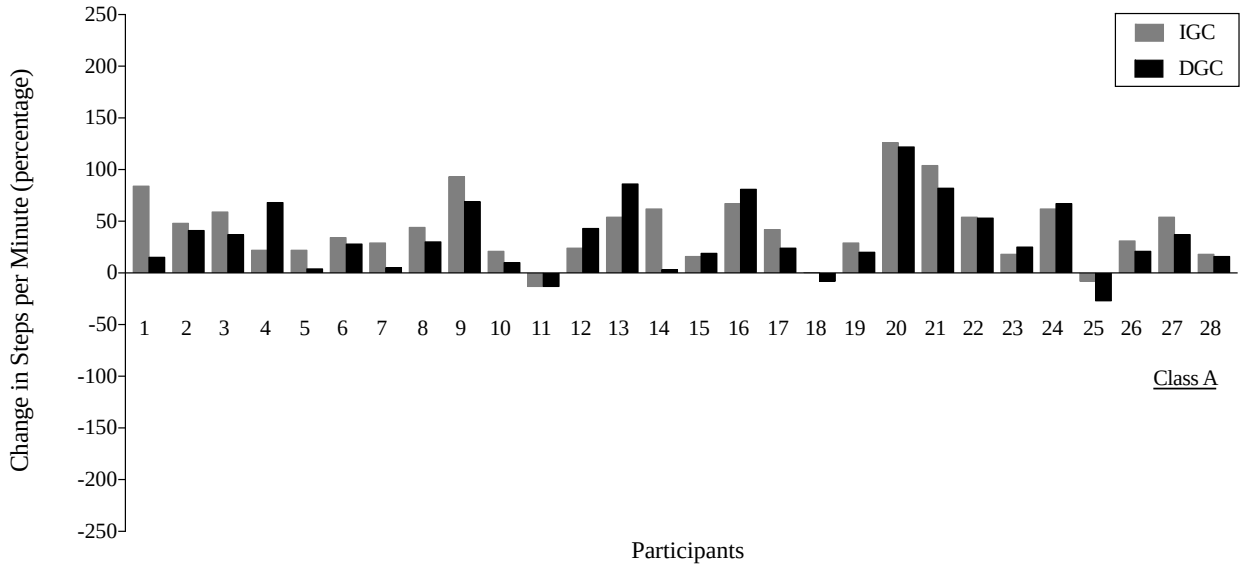
Mean Steps per Minute for Each Session Across Classrooms



Note. An asterisk above a data point represents a session when the class met the contingency requirement and received the reward.

Figure 2

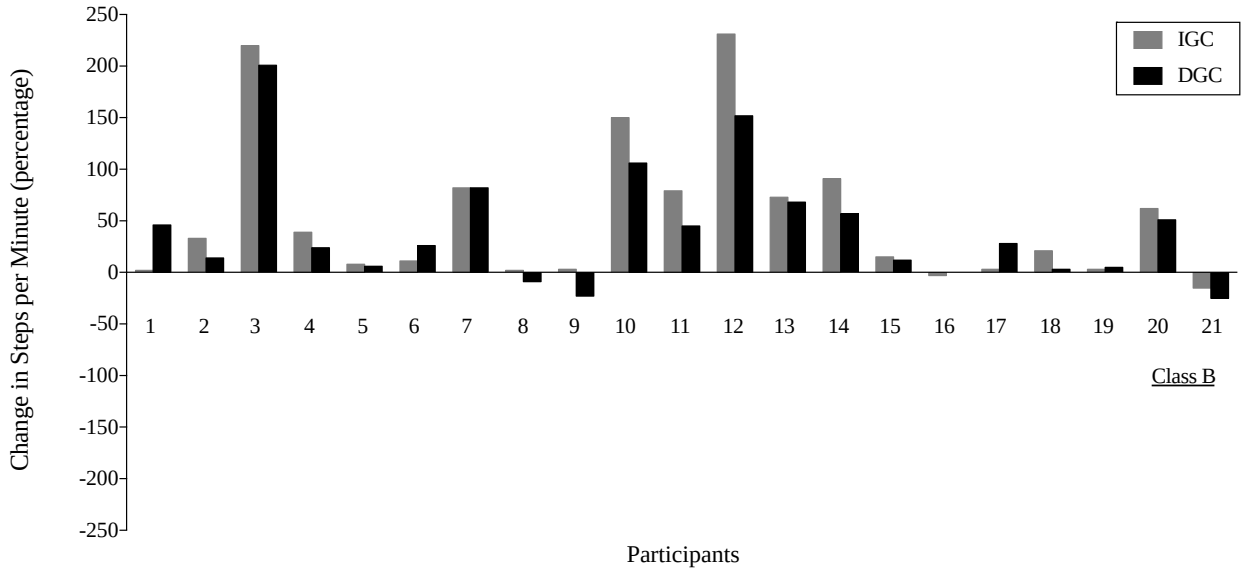
Change in Mean Steps per Minute for Participants in Class A



Note. Each bar represents the percentage of change in mean steps per minute from baseline during the group contingency comparison phase for Class A. Bars above the x-axis denote an increase in the mean steps per minute from baseline and bars below the x-axis denote a decrease in the mean steps per minute from baseline.

Figure 3

Change in Mean Steps per Minute for Participants in Class B



Note. Each bar represents the percentage of change in mean steps per minute from baseline during the group contingency comparison phase for Class B. Bars above the x-axis denote an increase in the mean steps per minute from baseline and bars below the x-axis denote a decrease in the mean steps per minute from baseline.

Figure 4

Mean Rate of Positive and Negative Statements per Minute During Presession and Postsession Periods in Class A

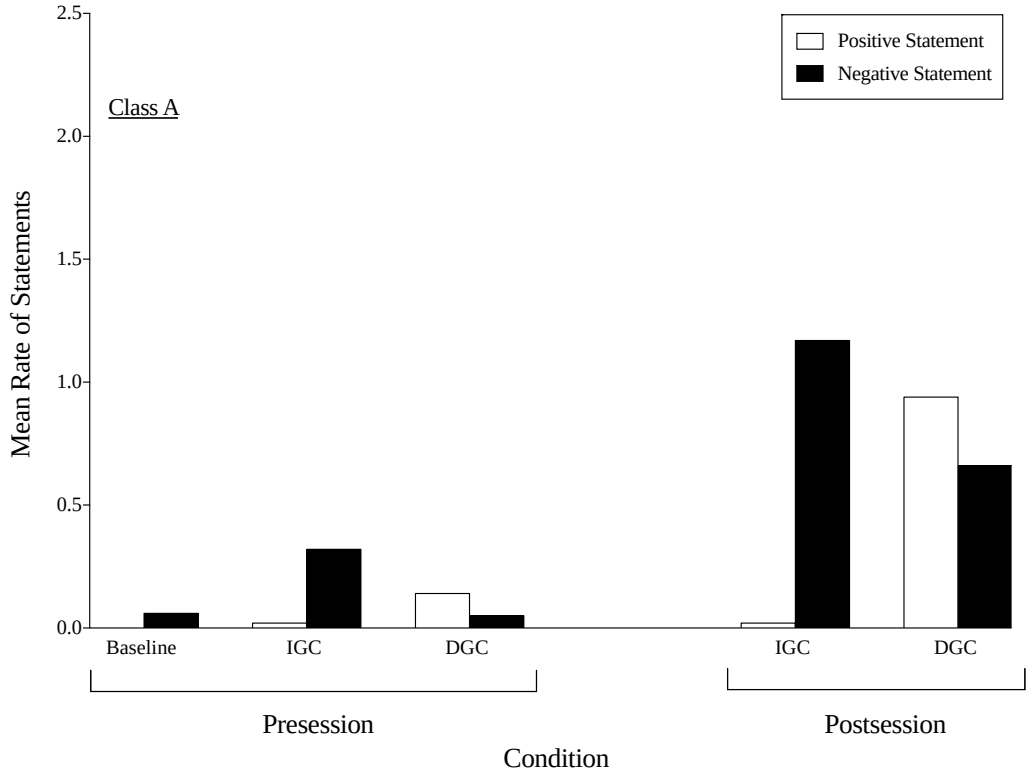


Figure 5

Mean Rate of Positive and Negative Statements per Minute During Presession and Postsession Periods in Class B

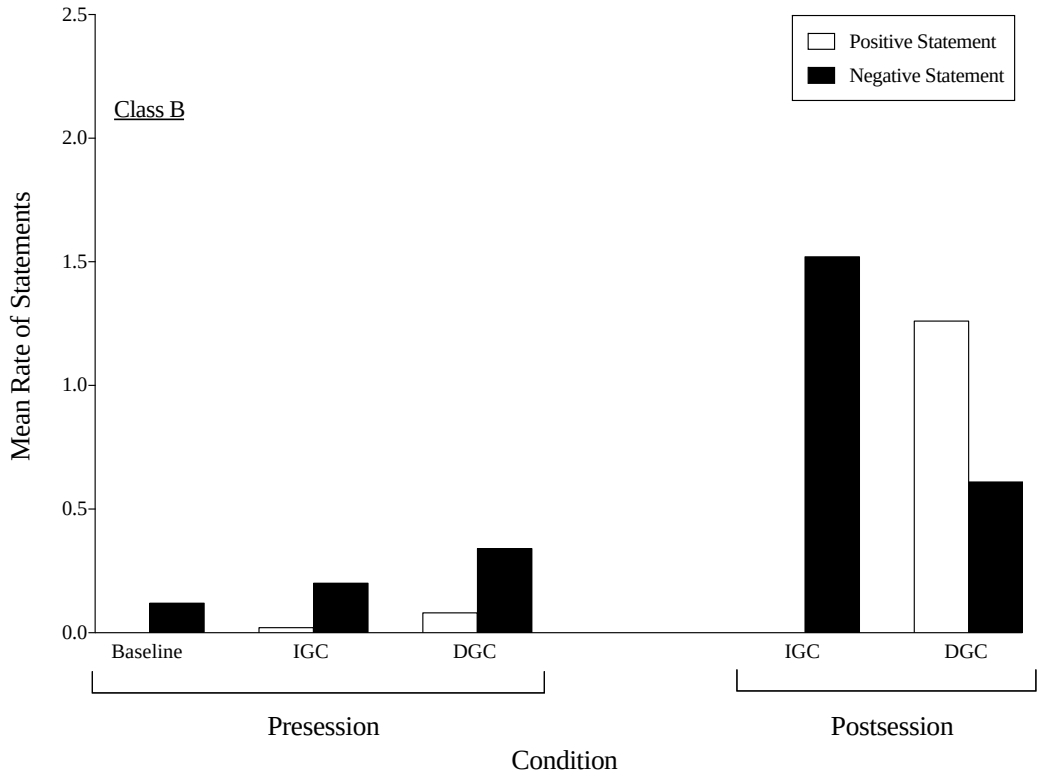


Figure 6

Mean Rate of Statements per Minute During Postsession Periods When Participants in Class A Received or Did Not Receive the Reward

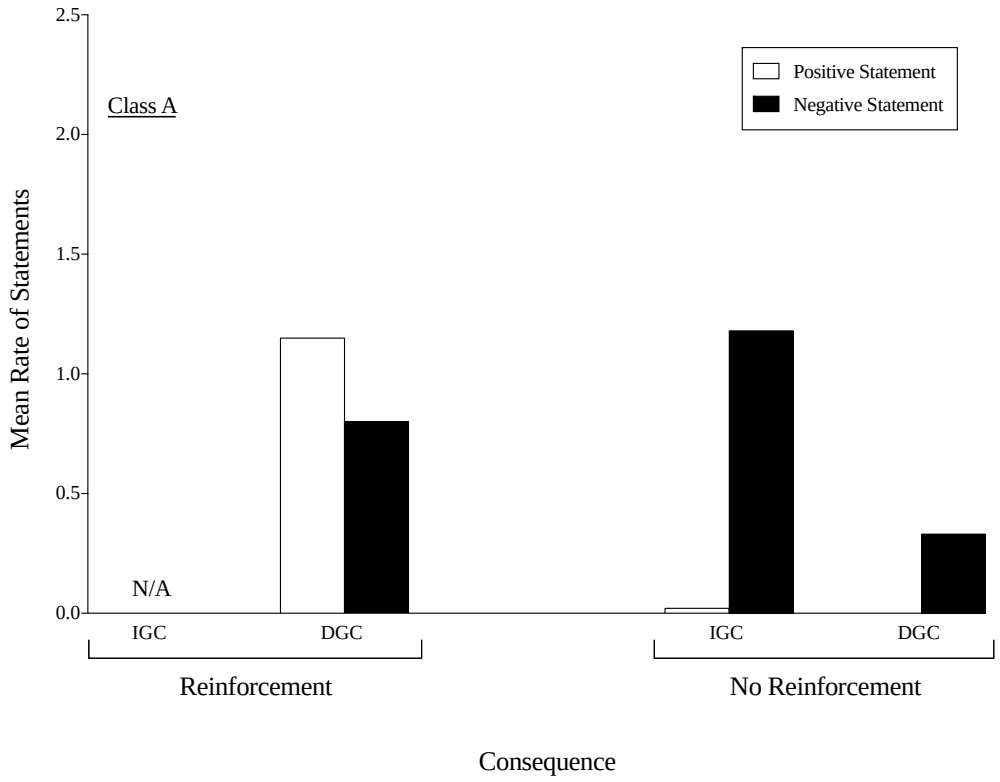
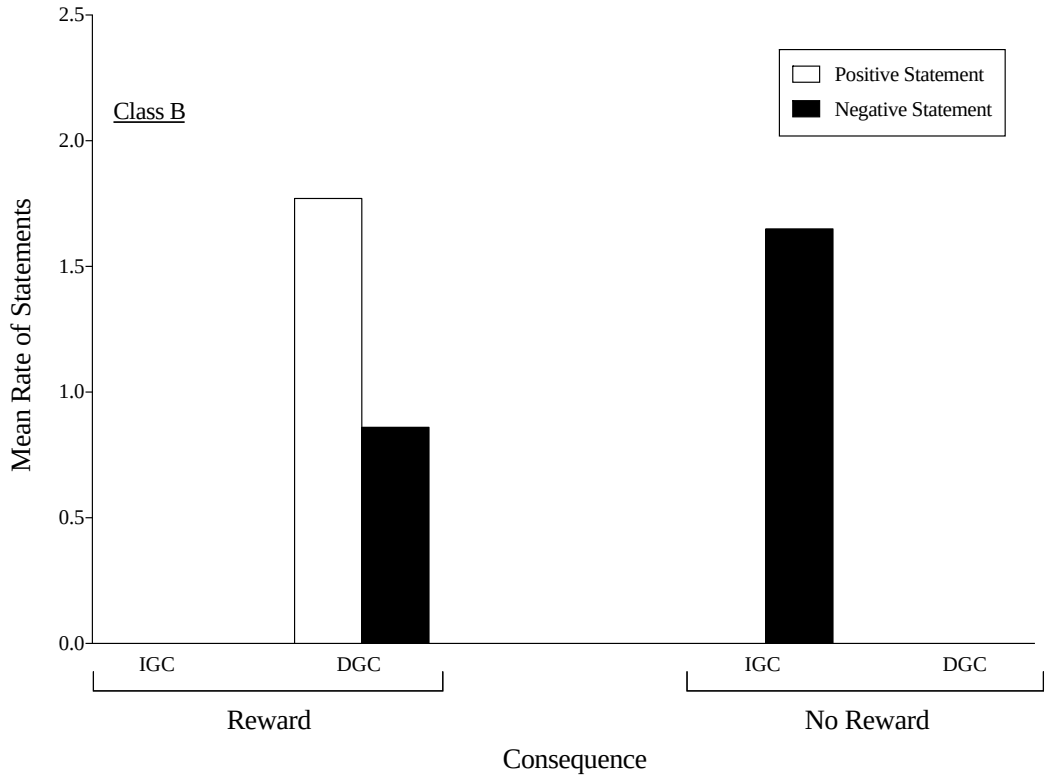


Figure 7

Mean Rate of Statements per Minute During Postsession Periods When Participants in Class B Received or Did Not Receive the Reward



Appendix A
Letter of Invitation for Schools

Project Title: A comparison of interdependent and dependent group contingencies to increase physical activity in students during recess

Principal Investigator: Dr. Kimberley Zonneveld, BCBA-D, Associate Professor
Department of Applied Disability Studies
Email: kzonneveld@brocku.ca Ph: (905) 688-5550 x6708
Principal Student Investigator: Madeline Asaro, M.A. Student
Department of Applied Disability Studies
Email: ma16lp@brocku.ca

INVITATION

Your school is invited to participate in a research project that aims to increase the amount of physical activity students engage in during recess. We will compare the effects of two interventions called an interdependent group contingency (IGC) and a dependent group contingency (DGC) to increase physical activity in the entire class. Both interventions have been shown to be effective at increasing physical activity in children, but we want to see which one, if either is better and/or quicker. To determine this, we will measure the number of steps each student takes during recess through a pedometer. Both interventions encourage physical activity and involve rewarding the entire class if the students reach the step goal.

WHAT'S INVOLVED

We will begin by teaching the students how to wear a pedometer. We will have them wear it for several days during recess to practice how to put it on and take it off. At the same time, we will work together with the classroom teacher to determine a list of 10 activities and items the class enjoys. We will then have students complete an individual survey to determine which of these 10 activities and items they like best. These will be used as rewards for meeting the step goal in this study.

To get a better idea of the amount of physical activity the students are already engaging in during recess, we will first measure the number of steps they take during recess before either intervention is implemented. Both interventions we are comparing are similar. In each condition, the type of intervention being used will be announced to the class before recess. After the researcher tells the students it is time for recess and asks them to line up, the researcher will hand out the pedometers and ask the students to put them on. In the IGC, the class will be told that if everyone increases the number of steps they take at recess, the whole class will get a reward. If the whole class doesn't take more steps, then they will have to try to get the reward during another recess. In the DGC, the class will be told if one student (the hero) in the class increases the number of steps they take at recess, the whole class will get a reward. If the hero doesn't take more steps, then the class will have to try to get the reward during another recess. The hero will be randomly selected, will change every recess, and will be a secret to the students. The reward for both interventions will be randomly select from the pre-determined list of preferred activities and items the teacher and students developed.

In addition to the number of steps students take during recess, we will also collect information on the types of peer statements students use. This will provide valuable information, especially in the event that both interventions are equally effective. For example, if both interventions are equally effective, but one reliably increases positive peer statements, future teachers and practitioners will likely use the intervention that increases positive peer statements. We will collect this information by videotaping student interactions before and after each recess period when the researcher is with the students. This will ensure in the future educators and practitioners have all of the relevant information to choose an intervention that not only increases physical activity but also positive peer statements.

This study will require minimal classroom time. Each session will last approximately 30 minutes – the length of recess plus roughly five minutes before and after recess. The researcher will implement everything related to the intervention including handing out and collecting pedometers, collecting data, and delivering the rewards. Occasionally, we may ask the teachers to deliver the reward if they agree and if it is more appropriate for them to provide it. For example, if the reward is an extra 5 minutes of recess during a recess the research team is not at the school, we will ask you to deliver this to the students. Teachers will approve the list of rewards we use for their classroom prior to the start of the study.

This study will take place over the course of approximately 1 to 3 months. We cannot determine the exact duration of the study in advance because the total number of days that we will need to run sessions at the school will depend on a few factors: the school schedule, teacher preference, weather, the research team schedule, as well as the consistency of the number of steps students take at recess across intervention conditions. We will be onsite 1 to 5 days per week throughout the study and will work with each individual teacher to find days that he or she prefers and that are the least disruptive to ongoing activities in his or her classroom. It should be noted that the greater the number of days we can be onsite each week, the shorter the overall duration of the study. We will follow all school procedures regarding notifying relevant school personnel of the days we will be onsite.

POTENTIAL BENEFITS AND RISKS

There are several benefits to participating in this study. Both interventions have been shown to be effective at increasing physical activity in students; therefore, the students may benefit from participating in this study by increasing their level of physical activity. Physical activity has been associated with numerous positive benefits for children and youth, including but not limited to: improved cardiovascular health, bone density, mental health, self-confidence, cognitive skills, overall academic achievement, and decreased symptoms of anxiety and depression. If you and the teachers wish, we would be happy to train the teachers how to implement these interventions in their classroom at the conclusion of the study free of charge. Finally, the results of this study will add to existing literature regarding the effects of group contingency interventions on increasing physical activity and will assist clinicians and educators in determining which variation is better and/or quicker.

PUBLICATION OF RESULTS

The class and individual results may be published in professional journals and presented at conferences or workshops. Please note that only pseudonyms will appear on any representation

of the data. While the province, age, sex, and diagnosis (or lack thereof) of the students will be made available, the name or specific location of residence of the students will not be made available in any published reports.

Feedback about the results of classrooms in your school participating in this study will be made available to you throughout the study upon request. Similarly, you can request the final results of the study, which we will either mail or email you (depending on your preference). If requested, we will send you this feedback one month after the study ends. Throughout the study, you may contact Dr. Kimberley Zonneveld at 905-688-5550 ext. 6708 or through email at kzonneveld@brocku.ca or Madeline Asaro at ma16lp@brocku.ca.

CONTACT INFORMATION AND ETHICS CLEARANCE

If you have any questions about this study or require further information, please contact Dr. Kimberley Zonneveld or Madeline Asaro using the contact information provided above. This study has been reviewed and received ethics clearance through the Research Ethics Board at Brock University (18-348) and the TDSB External Research Review Committee. If you have any comments or concerns about student and teacher rights as research participants, please contact the Brock Research Ethics Office at (905) 688-5550 Ext. 3035, reb@brocku.ca.

If you are interested in learning more about this study or would like your classroom to participate, please contact Dr. Kimberley Zonneveld or Madeline Asaro using the contact information provided above. We are looking forward to the opportunity to work with you.

Best Regards,

Dr. Kimberley Zonneveld, BCBA-D
Associate Professor
Department of Applied Disability Studies
KZONNEVELD@BROCKU.CA

Madeline Asaro
M. A. Student
Department of Applied Disability Studies
MA16LP@BROCKU.CA

Appendix B
Research Consent for Teachers

Project Title: A comparison of interdependent and dependent group contingencies to increase physical activity in students during recess

Principal Investigator: Dr. Kimberley Zonneveld, BCBA-D, Associate Professor
Department of Applied Disability Studies
Email: kzonneveld@brocku.ca Ph: (905) 688-5550 x6708
Principal Student Investigator: Madeline Asaro, M.A. Student
Department of Applied Disability Studies
Email: ma16lp@brocku.ca

INVITATION

You are invited to participate in a research project that aims to increase the amount of physical activity students engage in during recess. We will compare the effects of two interventions called an interdependent group contingency (IGC) and a dependent group contingency (DGC) to increase physical activity in the entire class. Both interventions have been shown to be effective at increasing physical activity in children, but we want to see which one, if either is better and/or quicker. To determine this, we will measure the number of steps each student takes during recess through a pedometer. Both interventions encourage physical activity and involve rewarding the entire class if the students reach the step goal.

WHAT'S INVOLVED

This study will require minimal classroom time. Each session will last approximately 30 minutes – the length of recess plus roughly five minutes before and after recess. You will have to be present in the classroom during the time before and after recess. We will work with you to determine a list of 10 activities and items the class enjoys. Then, we will have students complete a survey to determine which of these 10 activities and items they like the best; these will be used as rewards for meeting the step goal. The researcher will implement everything related to the intervention, including handing out and collecting pedometers, collecting data, and delivering the rewards. Occasionally, we may ask you to deliver the reward if you agree and if it is more appropriate for you to provide it. For example, if the reward is an extra 5 minutes of recess during a recess the research team is not at the school, we will ask you to deliver this to the students. Teachers will approve the list of rewards we use for their classroom prior to the start of the study.

This study will take place over the course of approximately 1 to 3 months. We cannot determine the exact duration of the study in advance because the total number of days that we will need to run sessions at the school will depend on a few factors: the school schedule, teacher preference, weather, the research team schedule, as well as the consistency of the number of steps students take at recess across intervention conditions. We will be onsite 1 to 5 days per week throughout the study and will work with you to find days that you prefer and that are the least disruptive to ongoing activities in your classroom. It should be noted that the greater the number of days we can be onsite each week, the shorter the overall duration of the study. We will follow all school procedures regarding notifying relevant school personnel of the days we will be onsite. At the conclusion of the study, we will ask you to complete a survey letting us know your perspective on the interventions.

POTENTIAL BENEFITS AND RISKS

There are several benefits to participating in this study for you as an educator and for your students. Since the interventions are being implemented during recess - an already scheduled break from educational material - it requires minimal classroom time. Participating in this study presents no greater threat than you would experience outside of the study. If at the conclusion of the study, you would like to be trained on one or both of the interventions, we would be happy to provide this training free of charge.

Low levels of physical activity in children is a major concern in Canada and interventions aimed at increasing physical activity are needed. Since children spend the majority of their time in school, using pre-existing appropriate times for physical activity is critical in improving the physical activity levels of Canadian children. Both interventions have been shown to be effective at increasing physical activity in students; therefore, your students may benefit from participating in this study by increasing their level of physical activity. Physical activity has been associated with numerous positive benefits for children and youth, including but not limited to: improved cardiovascular health, bone density, mental health, self-confidence, cognitive skills, overall academic achievement, and decreased symptoms of anxiety and depression.

Finally, the results of this study will add to existing literature regarding the effects of group contingency interventions on increasing physical activity and will assist clinicians and educators in determining which variation is better. We hope to increase the physical activity of the participants and demonstrate an effective behavioural intervention that can be easily applied in a variety of other school settings.

CONFIDENTIALITY

Your responses to the survey questions, video recordings, and any other information you provide us is considered confidential. Only members of the research team will have access to this. We will refrain from using identifying information in e-mail correspondence, during presentations, or in the publication of these results. Once the study is complete, your name will be changed into a pseudonym. This pseudonym will be the name that appears on any representation of your responses to survey questions. A master list that links pseudonyms to real names will be stored on a network secured through Brock University's Information Technology Services.

Paper data collected during this study will be stored in a locked cabinet behind a locked door. Electronic data, including video recordings will be kept on a network secured through Brock University's Information Technology Services. All data will be kept for 2 years, after which time paper data will be securely shredded, and all electronic data (excluding video recordings) will be securely deleted from the secure network. Only the principal investigator and the students under her supervision will have access to the data.

VOLUNTARY PARTICIPATION

Participation in this study is voluntary. You may decline to answer any questions. Further, you may decide to withdraw from this study at any time up to and including the last study session and may do so without any reprisal from Brock University. If you choose to withdraw from the study, you will have the opportunity to decide what happens to your data. You may ask for it to

be securely destroyed, for it to be used in the study, or for it to be returned to you. If you choose to have the data returned to you, Madeline Asaro will be available to meet with you to return your data.

PUBLICATION OF RESULTS

Your confidential survey responses may be published in professional journals and presented at conferences or workshops as part of this study. Please note that only pseudonyms will appear on any representation of this information. While the province you teach in and your sex will be made available, your name and the specific location of your school will not be made available in any published reports.

Feedback about your classroom's results will be made available to you throughout the study upon request. Similarly, you can request the final results of the study, which we will either mail or email you (depending on your preference). If requested, we will send you this feedback one month after the study ends. Throughout the study, you may contact Dr. Kimberley Zonneveld at 905-688-5550 ext. 6708 or through email at kzonneveld@brocku.ca or Madeline Asaro at ma16lp@brocku.ca.

CONTACT INFORMATION AND ETHICS CLEARANCE

If you have any questions about this study or require further information, please contact Dr. Kimberley Zonneveld or Madeline Asaro using the contact information provided above. This study has been reviewed and received ethics clearance through the Research Ethics Board at Brock University (18-348) and through the TDSB External Research Review Committee. If you have any comments or concerns about your rights as a research participant, please contact the Brock Research Ethics Office at (905) 688-5550 Ext. 3035, reb@brocku.ca.

PARTICIPANT CONSENT

I , _____, agree to participate in the study described above. I have made this decision based on the information I have read in this form. I have had the opportunity to receive any additional details I wanted about the study and understand that I may ask questions in the future. I understand that I may withdraw this consent at any time.

Please note that members of the research team are under obligation to follow mandatory reporting laws. That is, if any instance of child abuse is disclosed to or observed by a member of the research team, that member is required to report it to child protective services.

If necessary, I consent to participate in this study: Yes No

Teacher's Name: _____ Ph./Email: _____

Signature: _____ Date: _____
(dd/mm/yy)

Appendix C
Research Participant Invitation Package

Research Participation Invitation
A Comparison of Interdependent and Dependent Group Contingencies to Increase Physical Activity in Students During Recess

Dear Parents/Guardians,

Your child is invited to participate in a research project with his/her entire class that aims to increase the amount of physical activity he/she engages in during recess. We will compare the effects of two interventions: an interdependent group contingency (IGC) and a dependent group contingency (DGC). Both interventions have been shown to be effective at increasing physical activity in children, but we want to see which one, if either, is better and/or quicker. To determine this, we will use a pedometer to measure the number of steps your child takes during recess. Both interventions encourage physical activity and involve rewarding the entire class if the students reach the step goal.

The attached consent form provides detailed information about this research, the potential benefits and risks, and information about how we will keep your child's data confidential. This study has been reviewed and received ethics clearance through the Research Ethics Board at Brock University (18-348) and through the Toronto District School Board External Research Review Committee. If you have any comments or concerns about your child's rights as a research participant, please contact the Brock Research Ethics Office at (905) 688-5550 Ext. 3035, reb@brocku.ca.

Participation is completely voluntary and will not affect your child's participation in other classroom activities and education. In addition, your child can withdraw from this study at any time. If you have any questions or concerns, please feel free to contact us.

If you would like your child to participate in this research project please sign and return the attached form to his/her classroom teacher by (date).

Thank you for your time,

Dr. Kimberley Zonneveld, BCBA-D
Associate Professor
Department of Applied Disability Studies
KZONNEVELD@BROCKU.CA

Madeline Asaro
M. A. Student
Department of Applied Disability Studies
MA16LP@BROCKU.CA

Research Consent for Participants

Project Title: A comparison of interdependent and dependent group contingencies to increase physical activity in students during recess

Principal Investigator: Dr. Kimberley Zonneveld, BCBA-D, Associate Professor
Department of Applied Disability Studies
Email: kzonneveld@brocku.ca Ph: (905) 688-5550 x6708
Principal Student Investigator: Madeline Asaro, M.A. Student
Department of Applied Disability Studies
Email: ma16lp@brocku.ca

INVITATION

Your child is invited to participate in a research project that aims to increase the amount of physical activity he/she engages in during recess. We will compare the effects of two interventions called an interdependent group contingency (IGC) and a dependent group contingency (DGC) to increase physical activity in his/her entire class. Both interventions have been shown to be effective at increasing physical activity in children, but we want to see which one, if either is better and/or quicker. To determine this, we will measure the number of steps your child takes during recess through a pedometer. Both interventions encourage physical activity and involve rewarding the entire class if the students reach the step goal.

WHAT'S INVOLVED

We will begin by teaching the students how to wear a pedometer. We will have them wear it for several days during recess to practice how to put it on and take it off. At the same time, we will work together with the classroom teacher to determine a list of 10 activities and items the class enjoys. We will have students complete an individual survey to determine which of these 10 activities and items they like best. These will be used as rewards for meeting the step goal in this study.

To get a better idea of the amount of physical activity the students are already engaging in during recess, we will first measure the number of steps they take during recess before either intervention is implemented. Both interventions we are comparing are very similar. In each condition, the type of intervention being used will be announced to the class before recess. After the researcher tells the students it is time for recess and asks students to line up, the researcher will hand out the pedometers and ask the students to put them on. In the IGC, the class will be told that if everyone increases the number of steps they take at recess, the whole class will get a reward. If the whole class doesn't take more steps, then they will have to try to get the reward during another recess. In the DGC, the class will be told if one student (the hero) in the class increases the number of steps they take at recess, the whole class will get a reward. If the hero doesn't take more steps, then the class will have to try to get the reward during another recess. The hero will be randomly selected, will change every recess, and will be a secret to the students. The reward for both interventions will be randomly select from the pre-determined list of preferred activities and items the teacher and students developed.

In addition to the number of steps students take during recess, we will also collect information on the types of peer statements students use. This will provide valuable information, especially in

the event that both interventions are equally effective. For example, if both interventions are equally effective, but one reliably increases positive peer statements, future teachers and practitioners will likely use the intervention that increases positive peer statements. We will collect this information by videotaping student interactions before and after each recess period when the researcher is with the students. This will ensure in the future educators and practitioners have all of the relevant information to choose an intervention that not only increases physical activity but also positive peer statements.

With your consent, sessions will be video-taped to help us collect accurate data and to measure the researcher's behaviour. The majority of video recording will be done behind the students; therefore, it will mainly include the back or side of students' heads/faces. Only members of the research team will have access to these videos.

This study will take place over the course of approximately 1 to 3 months. We cannot determine the exact duration of the study in advance because the total number of days that we will need to run sessions at the school will depend on a few factors: the school schedule, teacher preference, weather, the research team schedule, as well as the consistency of the number of steps students take at recess across intervention conditions. We will be onsite 1 to 5 days per week throughout the study and will work with each individual teacher to find days that he or she prefers and that are the least disruptive to ongoing activities in his or her classroom.

POTENTIAL BENEFITS AND RISKS

Although your child may not enjoy all aspects of this study, participating in this study presents no greater risk than he or she would experience during recess outside of the study. There may be a chance that a child overexerts him or herself at recess or that while running and playing he or she may fall. To mitigate this, the research team will have up-to-date CPR training.

Some students may feel worried that they will not reach the predetermined step goal. They may also become upset if the secret hero or the class does not achieve the goal. We will maintain a positive environment for the entirety of the experiment, regardless of the outcome for each specific recess. We will try to schedule sessions frequently to ensure that if students becomes frustrated that the class did not receive the reward, they will have another opportunity soon to get the reward. We will not deliver reprimands or other forms of punishment for not reaching the step goal nor we will not tell the students what reward they would have won if the goal was achieved.

Both interventions have been shown to be effective at increasing physical activity in students. Therefore, your child may benefit from participating in this study by increasing his or her level of physical activity. Once we identify the superior intervention, we can teach the teachers this relatively simple strategy so the students can continue to increase their physical activity during recess.

Low levels of physical activity in children is a major concern in Canada and interventions aimed at increasing physical activity are needed. Since children spend the majority of their time in school, using pre-existing appropriate times for physical activity is critical in improving the physical activity levels of Canadian children. Since the intervention is being conducted during

recess - an already scheduled break from educational material - it requires minimal classroom time. Physical activity has been associated with numerous positive benefits for children and youth, including but not limited to: improved cardiovascular health, bone density, mental health, self-confidence, cognitive skills, overall academic achievement, and decreased symptoms of anxiety and depression. By participating in this study, we hope to increase your child's physical activity and demonstrate an effective behavioural intervention that can be easily applied in a variety of other school settings.

CONFIDENTIALITY

Your child's data, video/audio recordings of your child, and any information you provide us is considered confidential. Only members of the research team will have access to the data and video recordings. We will refrain from using identifying information in e-mail correspondence, during presentations, or in the publication of these results. Once the data are fully collected, your child's name will be changed to a pseudonym. This pseudonym will be the name that appears on any representation of your child's data. A master list that links pseudonyms to real names will be stored on a network secured through Brock University's Information Technology Services.

Paper data collected during this study will be stored in a locked cabinet behind a locked door. Electronic data, including video/audio recordings, will be kept on a network secured through Brock University's Information Technology Services. All data will be kept for 2 years, after which time paper data will be securely shredded and all electronic data (excluding video recordings) will be securely deleted from the secure network. If you provide consent for video recordings, all video recordings will be stripped of all personal identifiers. Only the principal investigator and students under her supervision will have access to the data.

VOLUNTARY PARTICIPATION

Participation in this study is voluntary. You may decline to answer any questions or have your child participate in any component of the study. Further, you may decide to withdraw from this study at any time up to and including the last study session and may do so without any reprisal from Brock University. If you choose to withdraw your child from the study, you will have the opportunity to decide what happens to his or her data. You may ask for it to be securely destroyed, for it to be used in the study, or for it to be returned to you. If you choose to have the data returned to you, Madeline Asaro will be available to meet with you to return your child's data.

We will also obtain verbal assent from your child to participate in this study. If your child revokes assent for four consecutive sessions, we will excuse him or her from the study.

PUBLICATION OF RESULTS

Your child's class and individual results may be published in professional journals and may be presented at conferences or workshops. Please note that only pseudonyms will appear on any representation of your child's data. While the province, age, sex, and diagnosis (or lack thereof) of your child will be made available, the name or specific location of residence of your child will not be made available in any published reports.

Feedback about the results of the classroom will be made available to you throughout the study upon request. Similarly, you can request the final results of the study, which we will either mail or email you (depending on your preference). If requested, we will send you this feedback one month after the study ends. Throughout the study, you may contact Dr. Kimberley Zonneveld at 905-688-5550 ext. 6708 or through email at kzonneveld@brocku.ca or Madeline Asaro at ma16lp@brocku.ca.

CONTACT INFORMATION AND ETHICS CLEARANCE

If you have any questions about this study or require further information, please contact Dr. Kimberley Zonneveld or Madeline Asaro using the contact information provided above. This study has been reviewed and received ethics clearance through the Research Ethics Board at Brock University (18-348) and through the (school board name) External Research Review Committee. If you have any comments or concerns about your child's rights as a research participant, please contact the Brock Research Ethics Office at (905) 688-5550 Ext. 3035, reb@brocku.ca.

PARTICIPANT CONSENT

I , _____, agree to allow my child to participate in the study described above. I have made this decision based on the information I have read in this form. I have had the opportunity to receive any additional details I wanted about the study and understand that I may ask questions in the future. I understand that I may withdraw this consent at any time.

Please note that members of the research team are under obligation to follow mandatory reporting laws. That is, if any instance of child abuse is disclosed to or observed by a member of the research team, that member is required to report it to child protective services.
If necessary, I consent to my child participating in this study: Yes No

Video Consent

Please note that video consent is not required for your child to participate in this study.
If you provide video consent, the name or specific location of residence of your child will not be made available in the video. The majority of video recording will be done behind the students; therefore, it will mainly include the back or side of the students' heads/faces.

I agree for video recordings of my child to be used for data-collection purposes only. I am aware that these videos will only be viewed by members of the research team. Yes No

Notification of Results

I would like to be notified of the final results of the study: Yes No

I would like to receive a graph of the class' progress in the study: Yes No

Child's Name: _____
Parent/Guardian Name: _____ Ph./Email: _____
Signature: _____ Date: _____
(dd/mm/yy)

Research Participation Invitation

A Comparison of Interdependent and Dependent Group Contingencies to Increase Physical Activity in Students During Recess

Dear Parents/Guardians,

Thank you for your response and allowing your child to participate in our research project. To keep things consistent within and across all classrooms, we have made a minor change that we would like to make you aware of. Specifically, we are switching from video recording to audio recording to gather information on the types of peer statements students say to one another before and after recess.

Because we have made this change, we would like to determine whether you consent to our research team audio recording your child. We will only use the video camera to record pedometer placement on the children whose parents previously provided video consent. We will not record any children's faces in any of the videos. Please note that audio consent is not required for your child to participate in this study.

I agree for audio recordings of my child to be used for data-collection purposes. I am aware that only members of the research team will listen to these audio files.

Yes No

Child's Name: _____

Parent/Guardian Name: _____

Signature: _____ Date: _____
(dd/mm/yy)

This study has been reviewed and received ethics clearance through the Research Ethics Board at Brock University (18-348) and through the Toronto District School Board External Research Review Committee. If you have any comments or concerns about your child's rights as a research participant, please contact the Brock Research Ethics Office at (905) 688-5550 Ext. 3035, reb@brocku.ca.

Participation is completely voluntary and will not affect your child's participation in other classroom activities and education. In addition, your child can withdraw from this study at any time. If you have any questions or concerns, please feel free to contact us. Please let us know your decision by date.

Thank you for your time,

Dr. Kimberley Zonneveld, BCBA-D
Associate Professor
Department of Applied Disability Studies
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Appendix D
Research Assent for Students

Project Title: A comparison of interdependent and dependent group contingencies to increase physical activity in students during recess

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"We are going to play two games with your class to see which one is a better game. I will come to your class just before recess and explain how the game works. Each recess that I am here, you will play one of the two games. During recess, you will wear a pedometer that will count how many steps you take. If it's okay with you, I will take some notes and video record what we do. We are going to have video cameras in the classroom. They will record me, the researcher, talking to the class and you talking to your friends. You will see when we start a nd stop the video cameras. You can tell me you don't want to be video recorded or that you want to stop at any time. When you come back from recess, I will look at the pedometer that I gave you at the beginning of recess to see how many steps you took. With each game, your whole class has a chance to win a reward together! If you decide you don't want to play the game during any recess you can tell me or a teacher outside and you won't get in any trouble. It's completely up to you if you want to play this game! Now can you write your name and check the box "yes, I want to play" or "no, I don't want to play"

Name: _____ Date: _____
(dd/mm/yy)

Yes, I want to play
No, I don't want to play

Appendix E
Data Collection Sheet

Session Data Sheet : Class_Phase_Session#_SessionPeriod_Date
Session Number: _____ Date: _____ Evaluator: _____ Classroom: N1

Phase	Session Start	Session End	Session Duration	Hero Pedometer Number	Step Goal Met	Session Notes
					Y N	

Pedometer Number	Student Name	In Class	Pedometer 0	# of Steps in Session	Steps per minute	Step Goal	Tampered with	Notes (at a club?)
1		Y N						
2		Y N						
3		Y N						
4		Y N						
5		Y N						
6		Y N						
7		Y N						
8		Y N						
9		Y N						
10		Y N						
11		Y N						
12		Y N						
13		Y N						

Pedometer Number	Student Name	In Class	Pedometer 0	# of Steps in Session	Steps per minute	Step Goal	Tampered with	Notes (at a club?)
15		Y N						
16		Y N						
17		Y N						
18		Y N						
19		Y N						
20		Y N						
21		Y N						
22		Y N						
23		Y N						
24		Y N						
26		Y N						
27		Y N						
28		Y N						
29		Y N						
30		Y N						

Procedural Integrity

Pre Session Script	Hero Selection	Arm Bands	Post Session Script	Reward Selection	Reward Delivery
Y N	Y N	Y N	Y N	Y N	Y N

Appendix F
Indirect Preference Assessment

Favourite Rewards: Class A

Please pick your top 5 favourite things!
Number 1 should be your most favourite item, number 2 your second most favourite item, number 3 your third most favourite item, all the way to 5.
If you see anything you don't like, put an 'X' beside it.

Item	Pick Your Top 5 / Put an X
1. 1 piece of gum and you can chew it during that class period	
2. 1 pen and you can use it during that class period	
3. Stickers	
4. Detailed colouring page	
5. Bookmark	
6. Candy cane	
7. Sour key candy	
8. Hot chocolate	
9. 15 minutes of free time right after recess	
10. 15 minutes of music right after recess	

Favourite Rewards: Class B

Please pick your top 5 favourite things!
Number 1 should be your most favourite item, number 2 your second most favourite item, number 3 your third most favourite item, all the way to 5.
If you see anything you don't like, put an 'X' beside it.

Item (class B)	Pick Your Top 5 / Put an X
1. Cool pencil	
2. Eraser	
3. Stickers	
4. Colouring pencil	
5. Colouring page	
6. Highlighter	
7. Coloured gel pen	
8. Paint brush	
9. Extra recess time	
10. Paint	

Appendix G
Teacher Social Validity Questionnaire

1. Which game increased physical activity most in your class (circle one):
   RED GAME BLUE GAME
2. Which game got most students involved (circle one):
   RED GAME BLUE GAME
3. In the future, I would be most likely to implement (circle one):
   RED GAME BLUE GAME

Please rate how strongly you agree with each statement from 1-5.

Blue Game

1. The blue game seemed to increase physical activity for the entire class.

1	2	3	4	5
Completely disagree		Neither agree nor disagree		Completely agree

2. The students enjoyed participating in the blue game.

1	2	3	4	5
Completely disagree		Neither agree nor disagree		Completely agree

3. The blue game was disruptive before and after recess.

1	2	3	4	5
Completely disagree		Neither agree nor disagree		Completely agree

4. The blue game seemed simple to implement.

1	2	3	4	5
Completely disagree		Neither agree nor disagree		Completely agree

5. I would want to be trained and try implementing the blue game in the future.

1	2	3	4	5
Completely disagree		Neither agree nor disagree		Completely agree

6. I think it would be feasible to implement the blue game in my class regularly.

1	2	3	4	5
Completely disagree		Neither agree nor disagree		Completely agree

Red Game

1. The red game seemed to increase physical activity for the entire class.

1	2	3	4	5
Completely disagree		Neither agree nor disagree		Completely agree

2. The students enjoyed participating in the red game.

1	2	3	4	5
Completely disagree		Neither agree nor disagree		Completely agree

3. The red game was disruptive before and after recess.

1	2	3	4	5
Completely disagree		Neither agree nor disagree		Completely agree

4. The red game seemed simple to implement.

1	2	3	4	5
Completely disagree		Neither agree nor disagree		Completely agree

5. I would want to be trained and try implementing the red game in the future.

1	2	3	4	5
Completely disagree		Neither agree nor disagree		Completely agree

6. I think it would be feasible to implement the blue game in my class regularly.

1	2	3	4	5
Completely disagree		Neither agree nor disagree		Completely agree

Any additional comments of feedback:

_____

_____

_____