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Monetary Reinforcement for Increasing Walking in Adults with Intellectual Disabilities

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Monetary Reinforcement for Increasing Walking in Adults with Intellectual Disabilities

by

Diego Valbuena

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

I dedicate this manuscript to my parents, Olga and Fernando, and to my brother JP. I would not be where I am today without your guidance, and love. Thank you for always supporting and encouraging me.

Acknowledgments

I would like to thank doctoral adviser, Dr. Miltenberger, for guiding me throughout my graduate education. I could not ask for a more dedicated and supportive mentor. Thank you for shaping me into the behavior analyst I am today.

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Abstract

Physical inactivity is a widespread problem associated with numerous health problems. Individuals with intellectual disabilities are at a high risk of living a sedentary lifestyle. Although a few studies have examined interventions consisting of goal-setting and reinforcement for increasing PA, no studies have evaluated the use of monetary reinforcement. Interventions using monetary reinforcement have been shown to be effective for increasing PA with typically developing adults. The present studies evaluated monetary reinforcement for increasing PA in adults with intellectual disabilities. Study 1 evaluate a session-based intervention where participants earned monetary rewards for attaining step count goals as recorded by pedometers. The intervention increased the rate of walking for all five participants, demonstrating experimental control with four participants. The study also found that a staff member implemented the intervention with fidelity and rated it as highly acceptable. Study 2 evaluated a whole-day intervention where participants earned monetary rewards for attaining daily step goals as measured by wrist-worn Fitbit Alta™ accelerometers. The whole-day intervention resulted in noticeable increases in daily steps for only two participants, with experimental control demonstrated for one participant. Discussion includes the advantages and limitations of the approaches in each study and recommendations for future studies.

Physical Activity

Physical Activity (PA) is defined as any bodily movement produced by skeletal muscles that produces energy expenditure (Caspersen, Powell & Christenson, 1985). More recently, PA has been classified based on the level of its intensity, with a focus on the levels that are associated with health benefits (e.g., Moderate- and Vigorous- intensity) (Centers for Disease Control and Prevention (CDC), 2015a). Moderate-intensity PA includes activities that such as walking fast, pushing a lawn mower, or doing water aerobics, which relative to an individual's personal capacity produce a score 5 or 6 on a scale from 0-10 (CDC, 2015a). Vigorous-intensity PA includes activities such as jogging, running, riding a bike on hills, or jumping rope, which relative to an individual's personal capacity produce a score a 7 or 8 on a scale from 0-10.

Assessment Methods

The two main categories of assessment methods for PA are self-report and objective measures.

Self-report. Self-report measures to assess PA include self-administered recalls, interviews, and diaries. They are mostly used in large scale epidemiological studies because of their ease of implementation and low cost (Loprinzi & Cardinal, 2011). Despite being commonly used, self-report assessment methods may not be valid or reliable (Prince, Hamel, Hardt, Gorber, & Tremblay, 2008). Troiano et al. (2007) compared accelerometer data from the National Health and Nutrition Examination Survey (2003-2004) to self-reported PA data. The results showed that although PA measured through self-report and accelerometer showed similar patterns in terms across genders and ages, the overall levels of activity appeared to be higher in self-reported

measures. For example, the accelerometer data found that when considering only activity that occurred in bouts of 8-10 min or greater, all age groups showed less than 5% adherence to recommended PA levels. Self-reported data from the same study estimated that approximately 51% adhered to the recommendations. Other National surveys they discussed have shown adherence to recommendations to be between 25-33%. One explanation for the discrepancy was that the accelerometers reported the actual levels of PA while people overestimated self-reported PA levels either by misclassifying sedentary- or light-intensity PA as either moderate-intensity PA, or overestimating its duration. The alternative explanation of self-report being the actual values, and accelerometers not capturing activities such as bicycling or swimming appeared less plausible because less than 10% and 5% of participants respectively reported engaging in those activities.

In a review, Prince et al. (2008) analyzed 187 articles that compared self-reported (e.g. questionnaires, diaries) and direct measures (pedometers, accelerometers, heart rate monitoring, indirect calorimetry, and doubly layered water) of PA in adults. They found that self-report measures may be problematic, especially when used as a substitute for direct observation methods. When compared to objective measures (which are more accurate), the investigators found that self-report measures were at times higher and at times lower than direct measures of PA. This lack of agreement suggests that not only may it be problematic to use self-report measures, but because they may be either higher or lower, correcting for the differences is also difficult. One trend that was apparent was that self-report measures overestimated high intensity (vigorous) PA when compared to direct measures.

Objective measures. Objective measures of PA include heart rate, the use of pedometers and accelerometers, and direct observation

Heart rate. One objective method which has been used to measure PA is heart rate monitoring. Heart rate monitors typically measure cardiac electrical activity via devices that contact the skin (VanCamp & Hayes, 2012) and produce a measure of beats per min. Heart-rate monitors record participants' heart rate, and often calculate calorie expenditure based on the participants' age, sex, height, and weight (Donaldson & Normand, 2009). Heart rate monitors of a particular brand, Polar, have been found valid and reliable when compared to electrocardiogram (e.g. Engström, Ottosson, Wohlfart, Grundström, & Wisén, 2012; Goodie, Larkin, & Schauss, 2000). These heart rate monitors have has been used to measure heart rate as a dependent measure in research on increasing PA, as well as in validating other observation systems (Donaldson & Normand, 2009; Larson, Normand, & Hustyi, 2011; McKenzie et al., 1991).

In terms of interpreting heart-rate as different intensities of PA, moderate-intensity PA encompasses activities that result in 50-70% of an individual's maximum heart rate. Maximum heart rate can be estimated by subtracting an individual's age from 220 (CDC, 2015c). Vigorous-intensity PA encompasses activities that result in 70-85% of an individual's maximum heart rate (CDC, 2015c).

Pedometers. Another objective measurement method that is commonly used to assess PA in studies implementing behavioral interventions is the use of pedometers (e.g. Ek, Miltenberger, & Valbuena, 2016; Normand, 2008; VanWormer, 2004; Zerger, Miller, Valbuena, & Miltenberger, 2016). A pedometer is a device that is usually worn on a person's waist which records the number of steps taken by responding to vertical acceleration during walking (Schneider, Crouter, & Bassett, 2004). Some pedometer models also estimate distance walked and energy expenditure. Many pedometer models have been found to be valid and reliable at

estimating steps in both controlled and free-living conditions (Schneider et al., 2004; Schneider, Crouter, Lukajic, & Bassett, 2003). For example, pedometers have been shown as a reliable measure of PA in studies that simultaneously use pedometers in different attachment sites, and have been validated against other measurement methods such as direct observation and heart rate. (Hustyi, Normand, & Larson, 2011; Loprinzi & Cardinal, 2011) Although pedometers are a useful measurement system because they are affordable and provide an objective estimate of mobility and therefore PA, they do have limitations. Because the main dependent measure they provide is number of steps taken, they cannot detect certain physical activities like riding bicycles, weight lifting, or swimming, and they also do not provide any contextual information, timing information, or information on the topography of the PA behavior (Hustyi et al., 2011; Loprinzi & Cardinal, 2011).

Because pedometers are a widely used assessment method, attention was given to how many steps should be taken per day to attain the benefits associated with increased levels of PA. Early recommendations suggested that adults should take 10,000 steps per day (Tudor-Locke & Bassett, 2004). However, more recently researchers have translated the recommendations based on the intensity of activity, where daily 30 min of moderate-intensity PA translates to 3,000-4,000 steps as long as they meet the following criteria: a) moderate-intensity (100 steps/min), b) at least 10-min bout duration, and c) occur above 5,000 daily steps which is considered sedentary (Tudor-Locke Hatano, Pangrazi, & Kang, 2008). There are currently not sufficient data to translate recommendations for individuals with disabilities, however similar recommendations of having activity occur in 10-min bouts, be at least moderate-intensity, and occur above activities performed in the course of daily living are in place when possible for the individual (Tudor-Locke et al., 2011).

Accelerometers. Other devices used for objective direct assessment of PA are accelerometers. Accelerometers measure acceleration (across one or three planes), and the measure of acceleration is then translated to measures of intensity (e.g., time engaged in moderate or vigorous intensity PA), caloric expenditure, distance, or steps. Accelerometers and commercially available activity monitors with accelerometers have been validated (Evenson, Gotto, & Furberg, 2015; Ferguson, Rowlands, Olds, & Maher, 2015; Noah, Spierer, Gu, & Bronner, 2013) and used in behavior analytic research (e.g., Hayes & VanCamp, 2015; Kurti & Dallery, 2013; Valbuena, Miltenberger, & Solley, 2015). Whereas pedometers are limited to measuring steps, accelerometers can differentiate between walking slowly and running, and capture vertical movements (e.g. squatting, or standing up from a seated position). Being able to quantify intensity of activity can be very useful for tracking progress towards recent PA recommendations which suggest activity should occur at a minimum of moderate-intensity to produce health benefits. Furthermore, accelerometers such as the Fitbit, measure the timing of the PA. Accelerometers have been found to be reliable and valid in measuring PA, but they have limitations. Although providing information on the timing and intensity of activity is an improvement from pedometers, accelerometers share the limitation of not providing any information on the topography or context of the activity.

Direct observation. Direct observation is a method by which trained observers record the behavior that constitutes PA during specific periods of time. Observers record behavior in natural settings and classify the behavior into specified categories depending on the recording system. Although the other objective measures described above provide reliable and accurate measures of PA levels, they do not provide information on the topography of the PA or the context or

setting in which it occurs. Direct observation provides contextual information which can be used to identify factors that influence PA (Loprinzi & Cardinal, 2011).

One direct observation system which measures PA levels, as well as environmental information and dietary information is the Behaviors of Eating and Activity for Children's Health Evaluation System (BEACHES). With the BEACHES system, the person recording observes the child for a 25s interval, and then has 35 s to score the behavior under various codes. In addition to activity level, this system also codes for physical location, eating behavior, people in the environment, antecedents and consequences. McKenzie et al. (1991) conducted a study to measure the reliability of BEACHES by observing and coding the behavior of 42 children (4-8 years old) in their homes and school for 8 weeks. They found that four 60-min observations with BEACHES were sufficient to produce reliable results. Also, they tested the validity of the PA categories by correlating them to heart rate monitors in an additional study. Although this system is helpful in that it also records eating behaviors, one limitation it has is that it still does not account for many contextual variables related to PA or the topography of PA.

Although the BEACHES system captures environmental information, information systems that provide more contextual information have been developed, such as the Observational System for Recording Activity in Children- Preschool/Home (OSRAC-P/OSRAC-H) (Loprinzi & Cardinal, 2011). With the OSRAC system, trained observers observe the participants for 5 s, and have 25 s to code the behavior. With the OSRAC-P, the observer records PA levels, and also codes for the topography of activity (e.g. running, walking), the location (indoor, outdoor), prompts, and contextual variables specific to preschool settings (such as group vs. individual activity). This observation system has been validated against pedometers (Hustyi et al., 2011). McIver, Brown, Pfeifer, Dowda, and Pate (2009) developed the OSRAC-H and

with it the observer records similar information to the OSRAC-P, but includes contextual variables related to children's homes (such as TV use) as well as parent and sibling engagement. Additionally, there are recording systems used to capture contextual information in groups of children as opposed to individual children such as the System for Observing Play and Leisure Activity in Youth (SOPLAY). In using SOPLAY to measure the PA of a group of children, an observer scans the target area and records the number of children engaging in each level of PA, type of activity, and the gender of the children engaging in each activity (Loprinzi & Cardinal, 2011).

The major advantage of direct observation systems for measuring PA is that they provide contextual information and not just level of PA as do many of the other methods. The information obtained from these systems can be used to determine under what settings and environmental factors PA levels increase or decrease. This in turn can lead to developing more effective interventions, because variables that could influence the dependent measure could be influenced to maximize the effectiveness and maintenance of the behavior change (McIver et al., 2009). However, one major limitation of direct observation methods is that they require intensive training of observers which must be present at all times to record the behavior, making it a very time-intensive method (Loprinzi & Cardinal, 2011). Therefore, direct observation is not appropriate for free living (whole day) recording of PA.

Risks and Benefits

Physical inactivity has been called one of the most important public health problems of the 21st century (Blair, 2009). It is one of the top 10 leading risk factors for death worldwide, as it is associated with a number of noncommunicable diseases (World Health Organization (WHO), 2015). In fact, engaging in regular PA has been shown to produce health benefits

including: weight control, reducing the risk of cardiovascular disease, reducing the risk of type II diabetes and metabolic syndrome, reducing the risk of colon and breast cancer, strengthening bones and muscles, improving ability to do daily activities, and reducing the risk of dying early (CDC, 2015d). Although engaging in any amount of PA is better than none, there are minimum levels of PA which are associated with the aforementioned health benefits. These minimum levels have been put forth in the PA Guidelines for Americans (US Department of Health and Human Services, 2008). For adults age 18-64, the 2008 PA Guidelines for Americans recommends engaging in at least 150 min of moderate-intensity PA, or 75 min of vigorous-intensity PA every week. The activity can be a combination of moderate- and vigorous- intensity, and it should be spread out through the week in bouts of at least 10 min. In addition to the aerobic recommendations, adults should engage in muscle-building activities on at least 2 days of the week.

Despite the recommendations by the USDHHS and CDC, many Americans are not engaging in the necessary levels of PA to achieve health benefits. In 2013, only about half of Americans (51.6%) reported engaging in at least 150 min of moderate-intensity or 75 min of vigorous-intensity PA each week (CDC, 2015e). Perhaps of more concern is the fact that in 2014, 23.7% of adults reported not engaging in any leisure time PA. The World Health Organization (WHO, 2015) found that in high income countries, 26% of men, and 35% of women were not active enough in 2010. The prevalence of inactivity has prompted 56% of WHO member states to implement policies to address the insufficient activity levels.

Individuals with Disabilities

For adults with disabilities, the 2008 recommendations remain the same whenever the individual is capable of engaging in PA (CDC, 2015b). When individuals with disabilities are unable to meet the guidelines, they should avoid inactivity by engaging in PA that is appropriate for their ability, even if it is more moderate. They are also encouraged to consult with their health-care provider for specific recommendations. In addition to the general health benefits mentioned above, increasing PA has been shown to improve muscle strength, balance, and quality of life in adults with intellectual disabilities (Bartlo & Klein, 2011).

The problem of inactivity is worse for individuals with disabilities; they are less likely to engage in the recommended PA levels than typically developing individuals (CDC, 2015b). A summary of data from the 2005 Behavioral Risk Surveillance System found that adults with disabilities were almost twice as likely to not engage in PA as adults without disabilities (CDC, 2007). Between 2009 and 2012, National Health Interview Survey data found that approximately 3% of adults reported a cognitive disability without mobility limitations. Individuals with cognitive disabilities were less likely than individuals without disability to engage in recommended levels of PA (38.3% vs. 53.7%) and more likely to be inactive by not engaging in any bouts of PA of at least 10 min (40.1% vs. 26.1%) (CDC, 2014). The same report also found that individuals with cognitive disabilities were more likely to have at least one of four chronic diseases (diabetes, cancer, stroke, heart disease) than individuals without disabilities (29.1% vs. 13.7%).

Similar results have been found suggesting that individuals with intellectual disabilities (ID) do not engage in the recommended levels of PA (based on objectives measure of PA). Peterson, Janz, and Lowe (2008) used pedometers to assess the activity levels of 131 individuals

with intellectual disabilities. The researchers found that only 15% of the participants met the then recommended 10,000 steps per day, and that 39% of participants walked fewer than 5,000 steps per day. The researchers also found that individuals with moderate ID took fewer steps per day on average (5,133) than individuals with mild ID (7,260), and that all participants were on average more active on weekdays (7,194) than on weekends (5,083). These results were similar to results reported by Stanish and Draheim (2005) who found that only 21% of participants with ID achieved 10,000 steps per day.

Behavioral Interventions to Promote PA

Behavioral interventions to promote PA fall into two general categories: session-based interventions implemented during discrete time periods (“sessions”) such as an hour or the time that elapses during recess, and whole day interventions implemented during the person’s entire waking day.

Session-Based Interventions

Studies have used behavioral principles to increase PA in sessions. For example, DeLuca and Holborn (1992) used a changing criterion design with variable-ratio (VR) reinforcement to increase the pedaling behavior of both obese and non-obese boys on a stationary bicycle. In this study, three obese and three non-obese children were allowed to ride the bicycle for up to 30-min sessions, and were not given further instructions. Revolutions per minute was recorded as the dependent measure. During the intervention, the children could earn points on a VR schedule that was set at a 15% increase from the mean responding in the previous phase. These points could then be exchanged for reinforcers that varied in point cost (including bikes, kites, model cars, and battery-operated games). The intervention increased the mean revolutions per minute for all six children, with two of the obese children approximating the same levels as the non-obese children at the end of the study.

Fogel, Miltenberger, Graves, and Koehler (2010) evaluated the effects of exergaming on PA of four children in a fifth grade physical education (PE) classroom. Exergaming is a technology that uses video games to increase exercise behavior. The researchers wanted to compare the time spent by inactive/overweight children engaging in PA in an

exergaming setting compared to a typical PE environment during 30-min sessions. The researchers utilized an alternating treatment design in which a regular PE condition was alternated with an exergaming condition, and time spent engaging in PA and number of opportunities to engage in PA was recorded for four children. During the PE condition, the teacher conducted class as usual, consisting of instructions and modeling skills and activities. During the exergaming condition, the PE classroom was turned into an exergaming lab, in which students rotated among 11 exergaming activities (such as *Konami Dance Dance Revolution with Sony Play Station, and Nintendo Wii Sports*) The researchers found that during the exergaming condition, the mean time of PA among the four participants was 9.2 min per session, compared to only 1.6 min during the PE condition. In terms of opportunities to engage in PA, the exergaming condition resulted in a mean of 11.6 min of opportunity per session, compared to 3.8 min of opportunity per session during PE. The researchers then analyzed the data for percentage of opportunities in which the children engaged in PA during each of the two conditions, resulting in a mean of 78% for exergaming versus a mean of 60% in the PE condition. In addition to the effectiveness at increasing PA in a PE classroom, the exergaming condition was rated favorably by both the teachers and students in social validity surveys. Shayne, Fogel, Miltenberger, and Koehler (2012) reported similar findings for active/normal weight children.

Huysti et al. (2011) evaluated an intervention consisting of goal-setting, feedback, and reinforcement for increasing steps and intensity of PA in two 4-year-old children. Sessions were conducted during 20-min recess in a playground. Across all sessions, steps were measured through hip-worn pedometers, and activity level was coded using the OSRAC system. The OSRAC activity codes were collapsed to only three levels: 1 (sedentary), 2 (light - stationary with limb movement, and slow movements), and 3 (moderate movements and fast movements).

During baseline, the screens on the pedometers were covered, and no feedback or consequences were provided. During intervention, step goals were set based on percentile schedules (the third highest step count of the preceding five sessions). The step goals were written on a sticker, and placed on the children's pedometers which now had the displays uncovered. Participants who met the goal were allowed to choose one item out of a prize box with various items that the teacher reported to be preferred by the children. The intervention was evaluated using a reversal (ABAB) design. Both participants showed higher mean step counts and higher percentage of intervals of MVPA (code level 3) during intervention phases relative to baseline phases. Additionally, participants met their goals on 78% and 67% of sessions. Another important finding of the study was that both measures (OSRAC direct observation and pedometers) corresponded, supporting the use of either measure for PA assessment.

Hayes and VanCamp (2015) used a reversal design to assess the effectiveness of a multi-component intervention (goal-setting, self-monitoring, and reinforcement) for increasing PA of six typically developing 8-year-old girls during recess. During all phases of the study participants wore Fitbit accelerometers during 20-min recess sessions. In baseline, the displays on the accelerometers were sealed with tape and the participants were not given any feedback on the number of steps they took. For intervention, the tape was removed allowing the participants to self-monitor their step counts throughout the session. They also received a piece of paper with the previous session's step count, as well as the goal for the current session. During the first intervention phase, the step goals were based on increasing the average step total from the preceding four sessions by 10%, and 20% once the goal was met on two consecutive sessions. During the second intervention phase, participants were given three goals (20%, 30%, and 40%). Participants who met their goals received praise and a reinforcer identified through a MSWO

preference assessment (leisure item costing \$3 or less) at the end of the session. Participants who did not meet their goal were encouraged to try to do so the following session. During the first intervention phase, all participants increased their steps from baseline levels to levels above the goals set for all sessions. Once the intervention was removed, steps decreased for all participants, with most reaching the levels of the first baseline. During the second intervention phase, the seven participants who were present increased their steps again, with four out of seven achieving the 40% increase goal. However, a limitation of the study was that only one session was conducted in the second intervention phase, meaning that the participant who was not there for that session did not complete a reversal. In addition to reporting steps per session, Hayes and VanCamp also evaluated the levels of MVPA across all sessions. The researchers reported the percentage of minutes that exceeded a rate of 100 steps per min, which is indicative of MVPA. During the first baseline, the average percentage of minutes of MVPA for all participants was 4%. It increased to a mean of 25% during the first intervention, and decreased to 13% in the second baseline. The intervention increased the steps taken, and the researchers demonstrate a method for interpreting step count data by level of intensity (MVPA).

More recently, Zerger et al. (2016) conducted a session-based study during recess at an elementary school. Sixteen children ages 9-12 wore pedometers at the hip every day during recess and physical education (PE). During baseline, all children wore a pedometer that was sealed with tape to prevent self-monitoring, and no feedback on step counts was provided. Following baseline, the children in the classroom were split into teams of two, pairing the children with the highest steps with the children with the lowest step counts during baseline. The pedometers were now uncovered, and the children were encouraged to observe their own and their partner's step count throughout the session. The children were told that they would be

competing in teams to see which pair would record the highest number of steps. Prior to the start of every intervention session, a bar graph depicting the team totals in descending order was shown to the class, and the three teams with the highest totals were announced. There were no additional consequences other than the feedback from the graphs and the pedometers. The intervention was implemented only during recess sessions in an ABAB design, and was not introduced at all during the PE sessions (allowing for a multielement comparison). Because the duration of recess and PE varied day to day, the step counts were reported as steps/min rather than total steps. The intervention resulted in a clear and immediate increase from baseline in the average steps per min during intervention with no overlapping data points across conditions (from 67 steps per min to 99 steps per min). During the return to baseline the steps/min decreased to levels below the first baseline (59 steps per min) and increased once again when the intervention was reintroduced (94 steps per min). An inspection of individual participants showed that 11 out of 16 participants responded to the intervention. Furthermore steps during PE sessions remained stable, even while steps during recess sessions were increasing with the intervention. This further supports the functional relationship between the intervention and the increase in steps, as there were no increases when baseline conditions were in place throughout the study. In addition to demonstrating an effective, cost-efficient intervention for increasing PA in children, the results support previous finding by Fogel et al. (2010) that children do not engage in high levels of PA during traditional PE.

The few studies using behavioral interventions to increase children's PA have shown promising results. The children in all five studies increased their PA (pedaling on a stationary bike in one study and walking in the others) when exposed to interventions which included components like goal-setting, feedback, and reinforcement. Despite the increases in activity, a

limitation in these studies is that activity is only measured during a limited time (usually under 1 hour). While the increases in activity during structured sessions may contribute to total recommended minutes engaged in PA, monitoring activity throughout the entire day may provide a better picture if individuals are meeting the weekly activity recommendations.

Whole-Day Interventions

More recently, attention has been given to increasing the levels of PA of individuals throughout the entire day, in a free-living approach, where individuals are encouraged to incorporate more PA and reduce leisure activity throughout the entire day. VanWormer (2004) used a reversal design (ABABCBC) to evaluate an intervention consisting of pedometer feedback and brief counseling through e-mail to increase the number of daily steps of three overweight adults. During baseline, the participants wore the pedometer for 5 days, but it was covered so they could not self-monitor. During the self-monitoring phase, the participants wore the pedometer uncovered, and recorded their daily step totals in a spreadsheet. During the self-monitoring plus e-counseling phase, in addition to the self-monitoring component, the participants had a 10-min weekly email conversation with the researchers in which they sent the current graphs, reviewed the current step totals, discussed weekly goals, and received praise. The intervention increased the participants' daily steps, with two of the three participants nearly doubling their baseline rates by the end of the intervention. However, the increase in PA was seen in the self-monitoring phase, and the addition of the e-counseling component only resulted in a significant increase in step totals for one of the participants. This finding suggests that self-monitoring alone can result in an increase of PA, and that feedback in this way did not produce significant improvements. Additionally, the two participants who increased their PA the most

also experienced the most weight loss, while the participant with the smaller increase in daily steps resulted in insignificant weight loss during the intervention.

Normand (2008) evaluated the effectiveness of a similar multi-component intervention for increasing the PA of four healthy non-obese adults. Using a multiple-baseline design across participants in addition to a reversal (for three out of four participants), Normand implemented a multi-component intervention consisting of goal setting, self-monitoring, and feedback. During baseline, participants wore pedometers that were covered (to prevent feedback), and the investigator recorded the daily totals. During the intervention phase, daily goals were set at the average for the step totals of the preceding week, as long as the participant had met the goal on at least 4 of the 7 previous days. The participants wore the pedometers uncovered (open feedback), and reported the daily totals to the experimenters in a daily email (self-monitoring). The feedback consisted of praise for meeting goals, encouragement when not meeting goals daily via email in response to the daily data, as well as weekly face-to-face meetings in which the experimenter reviewed graphs of the data up to that date, discussing trends and meeting or not meeting goals. The intervention resulted in an increase in the daily step totals for three out of the four participants. Additionally, all of the participants maintained their weight throughout the study. These findings suggest that a simple, low cost intervention like this can result in an increase in PA of healthy non-obese adults.

Donaldson and Normand (2009) evaluated the effect of a similar intervention (goal setting, self-monitoring, and feedback) on five adults (four obese and one overweight) who were all participating in a weight-management program. In this study, daily calorie expenditure (as calculated by Polar F6™ heart rate monitors) was used as the dependent measure. The experimenters evaluated the intervention using a multiple baseline design across participants, and

included a reversal for three out of the five participants. During baseline the participants wore sealed heart-rate monitors, and the experimenters recorded the daily calorie expenditure without providing any feedback. During the intervention, participants set their goals at 10% increase from baseline, wore the heart-rate monitors uncovered so they could monitor them throughout the day, and sent daily updated graphs through email to the researchers who responded with brief daily written feedback. Additionally, they met once a week with the experimenter for more thorough feedback. However, there were some limitations; the interventions were modified for some of the participants, the daily calorie expenditure data varied significantly from day to day within participants, and baseline levels did not always return during reversals. Although the intervention resulted in higher energy expenditure for all participants, a more detailed analysis of the components for each participant beyond the scope of this paper is merited.

Donlin Washington, Banna, and Gibson (2014) evaluated a prize-draw goal-setting intervention for increasing walking in 10 female and five male participants aged 18-26. The intervention was evaluated in an ABAB reversal design, each phase lasting one week. At the start of the study all participants were given an activity guide with instructions and strategies for increasing activity to recommended levels, and they were provided with Fitbit accelerometers which they were instructed to wear at all times they were awake. Every night participants texted the investigators their step totals, and during intervention they were texted back their goals. During baseline, participants earned a daily prize draw every day that they wore the Fitbit. In the prize draw during baseline, 50% of the time participants received praise only, and 50% of the time they received small prizes (less than \$5). During intervention, participants were given daily step goals based on percentile schedules (the 5th highest step total in the preceding 7 days for most participants). Participants who wore the Fitbits and reached the goal earned daily prize

draws. During intervention, the prize pool consisted of 50% praise, 42% small prizes, 5% medium prizes (under \$15), 2% large prizes (under \$50), and 1% jumbo prize (under \$120). Clear treatment effects were demonstrated with four participants (average increase of 4387 steps per day during intervention), and modest effects with an additional four (average increase of 2,845 steps per day). Furthermore, during baseline, only two subjects had an average step count above 10,000 steps, whereas during intervention only two subjects had an average step count below 10,000. Additionally, the authors conducted a bout analysis to determine active minutes, bout lengths, pause length, and within-bout step rate, and conducted an analysis to determine which of these variables most highly correlated with step totals. The researchers found the strongest correlation between active minutes and total steps, and the weakest between pause length and total steps. The correlations with bout lengths and within-bout step rates varied across subjects, suggesting that different participants changed their walking patterns in different ways. Conducting individual bout analyses can be useful for individualizing interventions (e.g., providing reinforcement contingent on increasing bout duration, bout initiation, or within-bout step rates). Such an analysis can also be useful for tracking activity towards PA recommendations that suggest that activity occur in bouts of at least 10 min.

Valbuena et al. (2015) evaluated a web-based multi-component intervention for increasing PA with and without videoconference coaching. Seven overweight or obese adults wore Fitbit accelerometers on their hips from the moment they woke up until the moment they went to sleep, every day of the week for the duration of the study. During baseline, the displays on the Fitbit accelerometers were covered with tamper evident tape to prevent participants from monitoring their activity data. Following baseline, the Fitbit intervention was staggered across participants in a multiple baseline design. The Fitbit intervention consisted of the components

that are commercially available via the web-based Fitbit program. The accelerometers were unsealed, and the participants were given access to their Fitbit accounts, which they could access on their computers or cell phones. Participants were also provided with scales that synced their daily weight to their Fitbit profiles after they weighed themselves first thing in the morning. The Fitbit website tracked participants' daily steps, estimated calories expended, daily weight, flights of stairs climbed, and self-reported caloric intake. For the Fitbit intervention phase, participants interacted with the program on their own without any instructions from the investigators, as if they had purchased the equipment on their own. The second intervention phase was identical to the Fitbit intervention, with the addition of a teleconference call once a week. During the call, a behavioral coach provided feedback and praise on goal attainment, and discussed strategies for increasing steps. The Fitbit intervention resulted in a modest increase in mean steps from baseline for three of the seven participants, although the level decreased throughout the phase for two participants. The addition of the behavior coach resulted in a mean increase in steps from baseline for five out of six participants who received this intervention, and the other participant showed a slight increase. This study evaluated the effects of these interventions over several weeks to several months in each phase, with data collection ranging from 147 to 449 days, allowing for the assessment of the maintenance of the effects.

Similar package interventions have been evaluated with children. Ek et al. (2016) implemented a multi-component intervention consisting of feedback, self-monitoring, and reinforcement contingencies on five overweight children. Number of steps recorded by pedometers was the dependent measure. The intervention was implemented using a multiple baseline design across participants, and the original intervention was modified (intervention 2) for three out of the five participants. During baseline, the participants wore a sealed pedometer

all day, and their parents recorded the daily step totals before bed time. Intervention 1 consisted of the parents and children deciding on goals and how to meet them, the children wearing the pedometers uncovered for self-monitoring, and receiving feedback from parents and reinforcers for meeting the goals (provided by the parents and ranged from money to computer time). The parents and children signed a behavioral contract which outlined the contingencies for receiving the reinforcement based on meeting the goals. Because the participants were not meeting their goals consistently with the initial intervention, intervention 2 was implemented for three of the five participants. Intervention 2 was identical to intervention 1, with the addition of a daily telephone call in which the researcher discussed, either with the parents or the participants, their daily progress at that point and how to meet the daily goal. They also included a follow up assessment for two of the participants, in which they wore covered pedometers, and the parents provided the reinforcement based on whether they believed the child engaged in an appropriate level of PA (not contingent on goal). Although intervention 1 resulted in a mean increase from baseline for four out of the five participants, the increase was not substantial, and intervention 2 was necessary for the participants to meet the final goals. Two out of the three participants that received intervention 2 met their goals on 100% of days, and the two participants that were assessed during follow-up continued to achieve 100% of their daily goals. The results suggest that the addition of the daily reminders may result in an increase in PA for children in an intervention where the parents are in charge of the contingencies.

Kuhl, Rudrud, Witts, and Schulze (2015) assessed the effects of individual and group goal setting on the daily steps taken by 30 typically-developing third-grade children in two classrooms. Participants wore pedometers on their hips at all times except when sleeping, swimming, or bathing, and data were collected for 24 hours Monday through Thursday. The

researchers assessed the effectiveness of the two interventions using a reversal ABACX, with X representing whichever of the two intervention conditions was more effective. In order to prevent any self-monitoring, pedometers were sealed with a sticker during baseline, and the researchers recorded the step counts every day, reset the pedometers, and sealed them shut again. Following baseline, each intervention was implemented with the children in a different classroom first, and then with the other. One intervention consisted of classroom cumulative step total goals. The goal for all students during this condition was 1,500 daily step increase from the class average during the last four days of baseline. The daily goals were also translated to a weekly cumulative goal by multiplying the individual goal by the number of participants and days of the week (four). If the class met the cumulative goal at the end of the week, all of the students earned the reinforcement (extra recess time, based on voting by the students). The second intervention consisted of individual goals, also with an increase of 1,500 daily step from the average of last four days of the preceding baseline. During this condition, each child had different daily goals, and the same reinforcer (extra recess time) was earned by the entire class if 80% of students met their daily goals on all four days of the week. After students in both classes were exposed to both interventions completing the reversal (ABAB), the class that was in the independent goal condition remained in that condition for another week, and the other classroom changed phase back to individual goals. The schedule of feedback and goals was then thinned from daily to every 2 days and then every 4 days. The researchers found that both interdependent group contingencies increased step counts, however for both classrooms, individual goals resulted in higher step totals (average of 4,800 and 5,000 steps above baseline for the two classrooms). When the feedback was faded to every 2 or 4 days, the average step count levels slightly decreased, suggesting importance of frequent feedback, however, they remained well above

baseline levels. The authors suggest that future studies examine these parameters in self-monitoring and feedback interventions.

Studies which evaluate whole-day PA interventions which use objective measures to track PA across several entire days allows for inferences to be drawn about whether interventions result in participants meeting activity recommendations. The few studies reviewed with adult populations mostly included self-monitoring, goal setting, and feedback, with one study including prize-draw reinforcement (Donlin Washington et al., 2014). Both studies with child participants included a reinforcement component. The results of these studies suggest that multi-component interventions with components such as self-monitoring, goal-setting, and feedback may be effective at increasing PA even without a reinforcement component. However, a limitation of these studies, excluding Valbuena et al. (2015) which measured daily step counts for several months in each phase, is that the data collection periods are too short (from one to a few weeks in each phase) to assess the maintenance of the effects. Future studies should assess the maintenance of whole-day interventions, with and without reinforcement components.

Interventions for Individuals with ID

Bartlo and Klein (2011) conducted a systematic review on the PA benefits and needs of adults with ID and concluded that there was not an adequate number of studies examining PA for adults with ID. Lang et al. (2010) conducted a review of the literature on physical exercise and individuals with Autism Spectrum Disorders. The review included 18 articles, and the analysis identified behavioral benefits associated with increasing PA. For example, 11 of the articles found evidence to support that increases in exercise resulted in decreases in stereotypy, two studies showed a decrease in disruptive classroom behavior, one study found decrease in aggression, and one study found a decrease in self-injurious behavior. Additionally, four studies

found improvements in academic behaviors. Although four studies found improvements in physical fitness, it is concerning that only one of the studies reviewed included PA as the dependent measure and showed increases in PA. In another review of PA and nutrition interventions for individuals with ID, Heller, McCubbin, Drum, and Peterson (2011), further support the conclusion that while there is evidence to support the related outcomes and benefits of increases in PA, there is a need for developing interventions to increase the actual health behaviors and demonstrate their sustainability. The authors also suggest that future research incorporate objective measures of PA, such as pedometers and accelerometers.

A few behavior analytic studies have evaluated interventions for increasing PA with this population. For example, Bennett, Eisman, French, Henderson, and Shultz (1989) evaluated a token reinforcement intervention for increasing the time spent pedaling and number of revolutions by three individuals with Down Syndrome on a stationary bike during sessions lasting up to 15-min. Participants received tokens contingent on completing a set number of revolutions at a given intensity of pedaling. Tokens were exchanged for tangible items and edible reinforcers immediately following the sessions. The token intervention substantially increased the time spent pedaling for all three participants. Todd and Reid (2006) implemented a multi-component intervention in an ABC design for increasing distance walked or snowshoed by three adolescents with autism during 1-hr sessions. Following baseline (A), participants received an intervention (B) consisting of self-monitoring and edible reinforcement (which was faded throughout the phase), followed by an intervention (C) consisting of self-monitoring and verbal cueing (encouraging statements and directions). Although both interventions resulted in an increase in distance walked or snowshoed from baseline, there were methodological limitations in the study. During baseline, participants only snowshoed, limiting any comparison with later

sessions where participants walked without snowshoes on. Furthermore, the design did not incorporate a reversal, therefore no functional relationship was demonstrated between the increase in activity and the intervention.

More recently, Krentz, Miltenberger, Valbuena (2016) evaluated a token reinforcement intervention for increasing walking in adults diagnosed with ID. The study was conducted at an adult day training facility, and five adult men with mild to moderate ID participated. The dependent measure in the study was the number of 50-m laps walked during a 1-hr session. During baseline, participants were instructed to walk as many laps as they wanted and were told the number of laps they had completed in a neutral tone as they completed each lap. There were no additional consequences provided, and participants could take breaks and return to walking as they desired throughout the session. Prior to intervention, a multiple stimulus without replacement preference assessment was conducted to identify highly preferred edible and tangible items to be earned as backup reinforcers during the intervention. During the intervention phase participants received a token upon completing each lap, which they placed in their personalized bags by the start of the walking loop. At the end of each session, participants could either exchange their tokens for a backup reinforcer or accumulate tokens for a costlier item. The intervention was evaluated in an ABAB reversal design. There was an immediate increase in the number of laps walked from baseline during the first intervention for four out of the five participants (the fifth participant walked similarly high levels of laps during baseline and the first intervention). During the return to baseline, all five participants decreased their laps to levels similar to those during the first baseline, and a decreasing trend for the participant with the high initial baseline levels. When the intervention was reintroduced, all five participants once again substantially increased their laps walked. This study demonstrated that an easy to implement and

not very costly (averaging from \$0.59-\$1.74 per day across participants) can be effective for increasing walking in adults with ID.

LaLonde, MacNeill, Eversole, Ragotzy, and Poling (2014) evaluated a multicomponent intervention (goal-setting and reinforcement) for increasing the daily steps taken by four young men and one young woman with ASD. The dependent measure of the study was the number of steps per day recorded by Fitbit Zip accelerometers. Across all phases of the study, participants wore the Fitbit Zip accelerometers while they attended a young adult training program from 8 am to 2 pm on weekdays. During baseline, the display on the accelerometers was covered with tape to prevent monitoring of the steps taken. Participants earned stickers for putting on the Fitbits in the mornings and returning them to the containers at the end of the day. Participants who earned two stickers could choose a prize at the end of the day out of a container with low cost tangible items. During intervention, the tape was removed from the accelerometers to allow self-monitoring and the researchers proposed goals that the participants agreed to each morning. The researchers initially proposed goals of 10% increase from baseline, and 10% increase if the goals were met on two consecutive days or until participants reached a terminal goal of 10,000 steps. Participants also recorded their daily step totals and whether they had met their goal on their own data sheets at the end of each day. Participants who met their goal could select an item from a prize bin consisting of items that they selected during a trip to a dollar store prior to the beginning of the phase. The intervention was evaluated in a combined multiple baseline and a brief reversal (ABAB) design. Following a staggered introduction of the intervention, all five participants gradually increased their step counts from baseline, with all participants consistently achieving goals above 10,000 steps by the end of the first intervention phase. There was then a brief return to baseline for four of the participants (ranging from two to seven sessions) during

which step counts dropped to levels similar to those of the first baseline phase. This was followed by a return to intervention (ranging from two to three sessions), where three out of the four participants increased the mean steps from the second baseline. This study demonstrated an effective intervention for increasing PA in adults with ID while they attend a day program. The authors suggest that future studies assess activity throughout the entire day, outside of time attending programs, as well as assess the maintenance and sustainability of such interventions.

Although there is research demonstrating the benefits of increasing PA in individuals with ID, there is a need for studies evaluating interventions that objectively assess PA as the dependent measure (Heller et al., 2011; Lang et al., 2010). The few studies reviewed have shown that interventions which include behavioral components such as goal-setting, self-monitoring, and reinforcement can increase PA in individuals with ID. All of the studies reviewed evaluated interventions which had a reinforcement component (including tokens, edibles, and tangible items). Another common feature of the studies reviewed is that all studies evaluated session-based interventions (with session duration ranging from 15 min to six hours). This highlights the need for studies measuring PA in individuals with ID throughout the whole-day, as well as for several weeks to assess the maintenance of the effects.

Interventions with Monetary Reinforcement

Interventions involving the use of monetary reinforcement and goal-setting have also been used to modify health behaviors. For example, monetary contingency management, where a behavior can be objectively monitored, and monetary reinforcement is delivered contingent on meeting a criterion (and withheld if the criterion is not met) has been shown to be effective at managing health related behaviors such as cocaine, opiate, and tobacco abstinence (Prendergast, Podus, Finney, Greenwell, & Roll, 2006). To make these interventions more accessible,

contingency management has been modified for internet delivery. For example, researchers delivered vouchers contingent on participant's cigarette smoking abstinence which was measured through participants submitting videos of themselves monitoring their carbon monoxide electronically (e.g., Dallery & Glenn, 2005; Stoops et al., 2009).

Because of the effectiveness of contingency management in modifying health behaviors, researchers have used monetary contingency management to increase PA. For example, Donlin-Washington et al. (2015) used an ABA design to evaluate deposit contracts for increasing walking in 19 healthy adults. Because monetary incentives can be costly, having participants deposit their own money and earn it back reduces the cost of the interventions. The researchers compared a \$50 program where participants either deposited half of the money (\$25) or no money. Ten participants were assigned to the \$25 deposit, and nine participants did not deposit any money. All participants wore Fitbit accelerometers during all times they were awake. During baseline (1-2 weeks), participants reported their daily steps to the investigators, but received no other programmed consequences. During intervention (3 weeks), participants earned \$1.50 for achieving their daily step goal, and \$2.65 bonuses for achieving their goals on three consecutive days. Following intervention, there was a 1-week return to baseline. Sixteen participants increased their average daily steps during intervention by over 1,600 steps from baseline, and nine of those participants showed a return to levels from the previous baseline once the intervention was removed. The researchers conducted statistical analyses and found significantly higher daily steps in intervention compared to baseline. The researchers also found no influence of amount deposited on daily steps or sensitivity to the reinforcers.

Kurti and Dallery (2013) conducted two experiments evaluating a web-based adaptation of a contingency management program for increasing walking in sedentary adults. Prior to the

start of the studies, participants went through a 5-day trial where they wore a Fitbit accelerometer and were allowed to self-monitor their activity. For Experiment 1, five women and one man over the age of 50 met the inclusion criterion of walking less than 6,000 steps per day and completed the study (four were excluded and one dropped out). The intervention implemented with the participants that met the inclusion criterion consisted of goal-setting and monetary reinforcement. During this phase, participants were emailed the step goal for that block, and participants who met the goals on at least 3 days out of 5-day blocks would earn the compensation at the end of the block. The compensation for meeting the goal on 3 days corresponded to the step goal for that block, such that meeting goals between 2,000 and 2,999 steps paid \$2.00, between 3,000 and 3,999 paid \$3.00 and so on, in addition to a \$3.00 bonus for moving to the next goal. Participants who failed to meet the goal on at least 3 out of the 5 days would keep the same goal for the following block, until they met the 3-day criteria. This was continued in a stepwise fashion until participants met a terminal goal of 10,000 steps on at least 3 days in a block. All six participants increased their step counts during the intervention, and experimental control was demonstrated in a changing criterion design. During the final two blocks with the terminal goal of 10,000 steps, participants increased their steps between 80% and 255.7% from the average steps during the screening phase. Throughout the course of the intervention, participants earned between \$56.00 and \$102.50. Experiment 2 was identical procedurally to experiment 1, except that participants did not receive any monetary reinforcement contingent on achieving their goals (They still received compensation for completing their activity logs). Six participants completed experiment 2, and the intervention was evaluated in a changing criterion design (based on the investigator assigned goals). Participants increased their steps from screening ranging from 8.27% to 186% with four out of

six exceeding 10,000 steps in the last goal. One difference in the results of study 2 was that the data were more variable in this experiment. The results suggested that goal setting, without contingency management may be a feasible intervention for increasing PA in adults.

Monetary contingency management has been shown to be an effective intervention for increasing PA in typically developing adults. A potential advantage of using money as opposed to predetermined items or activities, is that as a generalized conditioned reinforcer, it can be more resistant to satiation effects. Given the potential, similar interventions should be adapted for individuals with ID (studies reviewed in previous section used edibles or tangible items). In addition to serving as a potent reinforcer, providing individuals with ID money can present opportunities for engaging in (or learning if necessary) life and social skills when exchanging their money for backup reinforcers in the form of goods or services.

Covering Monetary Costs

A primary obstacle for the adoption and sustainability of monetary contingency management programs is the monetary cost. However, because increasing PA can result in monetary savings by reducing health problems, companies have found ways to incentivize individuals through monetary contingencies which are cost effective.

For example, several insurance companies and health organizations have partnered with Fitbit through their “Group Health” programs (<https://www.fitbit.com/group-health/partners>), where group contingency management programs are implemented using Fitbit activity monitors. One company, United Healthcare Motion™ provides employees who are enrolled in fully insured health plans with the opportunity to earn up to \$1460 per year contingent on incentive targets such as exceeding 10,000 steps/day, or engaging in bursts of 300 steps in 5 min, or 3,000 steps in 30 min (<https://www.uhc.com/health-and-wellness/info-at-a-glance/unitedhealthcare->

[motion](#)). John Hancock life insurance offers up to a 15% discount in premiums for engaging in health behaviors, such as engaging in PA measured by Fitbit activity monitors, doctor visits, and purchasing healthy food (<http://www.jhrewardslife.com/how-it-works>). Oscar Health insurance provides their members with a free Misfit activity tracker, and allows users to earn an Amazon gift card of up to \$20 each month. They earn \$1 for meeting their daily step count goal, which is determined from their previous activity (<http://blog.hioscar.com/post/105971652148/it-pays-to-walk-oscar-rewards-members-for-staying>).

For individuals diagnosed with ID there are some ways to cover the costs of such an intervention within the current system. For example, in Florida individuals who are enrolled in Consumer Directed Care Plus (CDC+) can choose what supports and services to allocate their funds in order to achieve their goals. Individuals receiving this type of funding could allocate part of their funds towards a PA contingency management intervention. Another way in which this can be achieved is through behavior contracts. Individuals receiving behavioral services, who work, receive Medicaid funding, or receive other financial support may choose and consent to put part of their own money to the side and earn it contingent on achieving the behavioral goals outlined in the behavior contract. If increasing PA is a behavior that is important to that individual, it can be targeted in a behavior contract in this manner.

Because the methods outlined above may not be feasible for all individuals, particularly those on a tight budget, a portion of federal funding, or a portion of private insurance funding for behavioral services could be allocated to PA contingency management. Given that increases in PA have been linked to improvements in both health related (CDC, 2015d; Heller et al., 2011) and behavioral outcomes (Heller et al., 2011; Lang et al., 2010), monetary contingency

management for increasing PA may be a low-cost and effective way to improve behavioral and health outcomes with this population while potentially resulting in long-term savings.

General Purpose

The purpose of the present studies was to add to the literature by assessing simple, easy to implement interventions for increasing PA in individuals with ID, an area that needs attention (Bartlo & Klein, 2011). The studies that have evaluated interventions for increasing PA in individuals with ID both in session (e.g. Krentz et al., 2016) and whole day (e.g. Lalonde et al., 2014), have used reinforcers in the form of leisure items and activities. Study 1 extended Krentz et al. (2016) by assessing the effectiveness of monetary reinforcement, rather than tangible items, for increasing walking during 1-hour sessions. Providing individuals with ID monetary reinforcement allows them to purchase the backup reinforcers of their choice, as well as promote life skills in that they need to purchase the items themselves in their community. It also extends Krentz et al. by evaluating the sustainability of such an intervention when implemented by staff rather than researchers. Study 2 evaluated a whole day monetary contingency management intervention similar to that used by Kurti and Dallery (2013). Although it was delivered in person rather than via internet, this contributes to the literature by evaluating a whole day monetary contingency management intervention with individuals with ID.

Study 1 Method

The purpose of this study was to evaluate the effects of a self-monitoring and monetary reinforcement intervention for increasing the rate of walking among adults with ID. In addition, this study evaluated the sustainability of the intervention when implemented by staff rather than experimenters.

Participants

Five men diagnosed with mild to moderate intellectual disability (ID) who attended a Life Skills Development (LSD) program participated in the study. Inclusion criteria for participants included: Being age 18-65, being diagnosed with mild to moderate ID (IQ scores ranging from 35-70), being ambulatory, being their own guardians, and answering “no” to all of the questions in the PA Readiness Questionnaire (PAR-Q) (see appendix A). The clinical director of the research site provided a pool of potential participants that she had observed to be the least active, from which the participants in the study were recruited. Stan was 46 years old and had diagnoses of mild intellectual disability (IQ score of 59), depression, hyperlipidemia, hypertension, and asthma. Drew was 37 years old and had diagnoses of mild/moderate intellectual disability (IQ score of 44), schizoaffective disorder/intermittent explosive disorder with self-injury and PICA, scoliosis, congenital deformities on both feet, hypertonic tonsils, benign gynecomastia, and gastroesophageal reflux disease. Eric was 50 years old and had diagnoses of mild/moderate intellectual disability (no IQ score in record), allergic dermatitis, obesity, cellulitis, hyperlipidemia, and history of lymphedema. John was 51 years old and had diagnoses of intellectual disability (IQ score of 66), schizophrenia, anemia, obesity,

hypochondriasis, tinea pedis, tenia curis, depression, and allergic rhinitis. Alex was 50 years old and had diagnoses of mild intellectual disability (no IQ score in record), bi-polar disorder with psychotic features, learning disorder (reading and written expression), suspect major depression, tardive dyskinesia, and diabetes.

One staff member participated in the study. She was a middle-aged female who had been working at the facility for several years. The inclusion criteria for the staff member included: At least 1 year of employment at the research site, a reported history of established rapport from working with the individuals at the site, being scheduled to work Monday through Friday at the time that the study was conducted, and willingness to participate in the research.

Setting

All sessions were conducted at an LSD facility where adults with ID attend from 8 a.m. to 2 p.m. and engaged in a variety of activities to learn vocational and independent living skills. Some individuals were part of work crews who got paid for landscaping and other duties. The study was conducted in the outdoor recreation area during the first 1-hr period of the day, when participants had no scheduled activities. The area was a large fenced area, with a basketball court, open grass field, sports equipment (e.g., basketball, horseshoes), and benches. There was ample space to walk or run in the area. There was also a covered walkway along the sides of the area where the participants could walk in shade. Participants walked freely throughout the area, although there was no structured walking course.

Materials

Yamax™ Digiwalker™ SW-200 pedometers were used to record participants' steps. This device has been validated in both free living and structured conditions and shown to be reliable and accurate (Schneider et al., 2003, 2004).

Response Measurement

The primary dependent measure was the average rate of walking (steps per min) for each session. Sessions were conducted from 9:00 to 10:00 a.m.. Because participants sometimes arrived late or had to leave early, there was not a consistent session length of 1 hour. Because session lengths varied across days and participants (average 50.3 min, range 21 to 70 min), we used steps per min as the main dependent measure, similar to Zerger, Miller, Valbuena, and Miltenberger (2017). The number of steps recorded during each session by the pedometers was divided by the duration (in min) of the session to calculate the average steps/min.

Another dependent measure was the integrity of implementation of the intervention by the staff member. We used a task-analysis (see Appendix B) to evaluate the accuracy of the staff's implementation of the intervention. A researcher observed the staff implementing the intervention and scored whether she completed the steps in the task analysis. To calculate the percentage of implementation accuracy, the number of steps completed correctly by the staff member was divided by the total number of steps in the task analysis and multiplied times 100.

Interobserver Agreement

A second independent observer recorded the step count displayed on the pedometer and session duration for each participant on a data sheet. The smaller recorded step count was divided by the larger step count and multiplied by 100 to calculate the percentage agreement for steps taken each session. The smaller session duration was divided by the larger session duration and multiplied times 100 to calculate the percentage agreement for the duration of each session. Interobserver agreement on step counts and session duration was evaluated during 36% of baseline and 50% of intervention sessions. Average interobserver agreement during baseline was

100% for step counts and 100% for session duration. Average interobserver agreement during intervention was 99.9% for step counts and 99.7% for session duration.

Treatment Integrity and Interobserver agreement

An independent observer scored the researcher's implementation using the task analysis (see Appendix B). To calculate the percentage of implementation accuracy, the number of steps completed correctly by the researcher was divided by the total number of steps in the task analysis and multiplied times 100. Researcher treatment integrity was assessed on 50% of sessions and averaged 100%.

A second independent observer scored the staff implementation using the task analysis. The percentage agreement was calculated by dividing the number of steps with agreements by the total number of steps, and multiplying times 100. Interobserver agreement on staff treatment integrity was assessed during 30% of staff-implemented intervention sessions. Agreement for staff treatment integrity was 100%.

Social Validity

Following the completion of the study, participants and the staff who implemented the intervention completed a social validity questionnaire to assess the perceived effectiveness and acceptability of the intervention (see appendix C and D).

Experimental Design and Procedures

An ABAB reversal design was used to evaluate the effectiveness of the intervention (A= baseline, B= intervention). A reversal design with simultaneous phase changes for all participants was used to prevent potential conflicts between participants that could arise from some having the ability to earn money while others did not. All sessions were conducted at the same time of the day in the same setting. Phase changes were made simultaneously for all

participants to prevent potential conflicts between the participants if some of them were able to earn money while others in the study could not. During all phases of the study participants wore a pedometer on their hip for the entire session. At the start of the session, participants walked up to the investigator, took their assigned pedometer, which was reset to zero steps, and placed it on their hip. Vocal feedback and/or physical assistance was provided if a participant was observed to be struggling to clip his pedometer on his hip, or if he clipped his pedometer anywhere other than his hip (e.g., to his pocket). At the end of the session, participants then handed their pedometer to the researcher. The researcher opened the pedometers and recorded the number of steps taken by each participant on a data sheet. The researchers also recorded the start time and end time of each session for each participant. Participants were instructed that they could stop walking to take breaks and resume at any time or stop the session all together at any point (during intervention phases they were paid at the end of the session for any steps they took during the session).

Baseline. Prior to the start of each session, the researcher made sure that the pedometers were reset to zero steps, and then taped them shut so participants could not see their steps. After giving participants their pedometers, the researcher told participants that they could walk as much or as little as they wanted. The researcher provided no further instructions or feedback and delivered no consequences. At the end of the session, the researcher simply collected the pedometers.

Intervention. Sessions began in the same way as during baseline, with the participants putting on the pedometers at the start of the session. However, now the pedometers were unsealed, so participants could open them and monitor their step counts during the session. In order to ensure that they understood how the pedometers worked, the investigator explained to

participants that the device counted the steps as one walked, and demonstrated the concept by walking with a pedometer with an open display. Participants were then allowed to wear an open pedometer so they can see how the number went up as they took steps, and the researcher answered any questions they had about how the pedometers work. The researcher instructed participants that during this phase, they would earn \$0.25 for every 1,000 steps they walked in the session. The researcher displayed a board that depicted the amount of money they could earn (in pictures of quarters and dollar bills) for every 1,000 steps they walked. To probe the participants' understanding of the contingency, the researcher provided participants with a pedometer displaying a step count ranging from 1,000 to 9,000 steps and asked them "how much would you earn if you walked this many steps?" Participants were required to answer three consecutive examples correctly before starting the intervention phase. This assessment was only conducted prior to implementation of the first intervention phase. At the start of every session, the researcher reminded the participants of the contingency (\$0.25 for every 1,000 steps), and the board with the amounts they could earn for every 1,000 steps they took was displayed at all times throughout the session. At the end of each session, the participants walked over to return the pedometers to the investigator. The investigator recorded the step count shown on each participant's pedometer, and gave the individual the amount of money earned for that session based on the contingency.

Staff implementation. After a stable rate of walking was observed in the second intervention phase, the same intervention was implemented by a staff member from the LSD rather than by the investigators. Prior to the start of this phase, the researchers used behavioral skills training to teach the staff member to implement the intervention. Training lasted 15 min and consisted of instructions, modeling, rehearsal, and feedback until the staff member

performed all of the steps correctly in a role play. The task analysis of the intervention was used to assess the accuracy of implementation. Every session, a researcher scored whether the staff member completed each step in the task analysis. The number of steps completed correctly was divided by the total number of steps and then multiplied times 100. The staff member's average accuracy of treatment implementation was 96.92% (ranging from 92.3-100%) across 10 sessions.

Study 1 Results

Figure 1 depicts the average steps/min during each session across all phases for all participants. The first intervention phase resulted in a noticeable increase in the rate of walking for all five participants. Upon the return to baseline, the rate of walking decreased for all five participants to levels similar to the initial baseline phase. Once the intervention was reintroduced, the rate of walking noticeably increased for four out of five participants (all except John). The higher rate of walking during the second intervention phase was maintained when the staff implemented the intervention for all four participants. Table 1 summarizes the average steps/min for each phase and the amount of money earned by each participant.

The results of the participant social validity questionnaires suggests that the intervention was perceived as effective by the participants and that the intervention had high acceptability. On a rating scale from 1 (strongly disagree) to 5 (strongly agree) the participants' answers averaged: 4.6 (range 4-5) for "I walk more now than I did before the walking program;" 4.6 (range 4-5) for "I enjoyed the walking program;" 3.8 (range 2-5) for "I will keep walking more now that the program is over;" and 3 (range 2-4) for "I will not continue walking more if I do not receive money for it." Additionally, several participants reported enjoying engaging in the exercise, earning money, and losing weight in response to an open ended question about what they liked about the program. In response to an open ended question about what they disliked about the program, two participants said there was nothing they didn't like, one participant said the hot temperature, one participant said it did not improve his knee, and one participant answered the noise from others engaging in problem behavior. The staff member's responses to the social

validity questionnaire suggest that she perceived the intervention as acceptable, effective and accessible. On a rating scale from 1 (strongly disagree) to 5 (strongly agree) the staff member answered: 4 for “the intervention was not too time-consuming and it was easy to implement;” 5 for “we should continue to implement this intervention now that the study is complete;” 5 for “this walking intervention is appropriate and sustainable with our current resources;” 5 for “I believe the participants engage in more PA now than before participating in the study;” 5 for “I believe it is appropriate to use monetary rewards for helping participants increase their PA;” and 5 for “I feel confident in my ability to implement the program on my own.” Additionally, responding to open ended questions she reported that she did not have issues implementing the program because everything was explained, that she thought the program was great and showed them the importance of exercise, that she would recommend it to other providers, and that there was nothing she did not like about the program.

Study 1 Discussion

This study showed that self-monitoring and monetary reinforcement increased the rate of walking in adults diagnosed with intellectual disabilities (ID) during an unstructured time block at a Life Skills Development (LSD) facility. Although there are a few overlapping data points across phases, there is a noticeable increase in the rate of walking for all five participants during the first intervention phase relative to baseline. This effect is replicated with four out of the five participants (all except John) during the second intervention phase, demonstrating experimental control.

The increases in PA may have been clinically significant for some of the participants. A guiding value for walking to be considered moderate intensity is a rate of 100 steps/min (Tudor-Locke, Craig, Brown, et al., 2011). Given that the average session duration was around 50 min, if participants average a rate exceeding 100 steps/min during at least three sessions per week, then participants could potentially engage in sufficient moderate-intensity PA to meet the recommended 150 min of moderate-intensity PA per week. Stan and Alex averaged above 100 steps/min during the majority of sessions in both intervention phases. Drew exceeded an average of 99 steps/min during four out of six sessions in the first intervention phase, and despite his inconsistent attendance related to issues outside of the study during the second intervention phase, he exceeded 100 steps/min on 4 out of 9 sessions in the second intervention phase. During the first intervention phase, Eric exceeded an average of 100 steps/min on six out of eight sessions, but only exceeded 100 steps/min in one session during the second intervention phase. John, who was the least responsive to the intervention, only exceeded an average of 100

steps/min in one session in each intervention phase. Based on these estimates, the PA levels of Stan (both intervention phases), Alex (both intervention phases), Drew (first intervention phase), and Eric (first intervention phase) appear to be in the range of the USDHHS recommendations for aerobic PA. However, given the extremely low levels of PA during baseline phases, even the more moderate increases in activity in the other intervention phases may be beneficial as avoiding inactivity even if the recommended activity levels are not met is recommended (CDC, 2015C). Future research could employ more advanced activity monitoring equipment (e.g. accelerometers) that can measure the intensity of participants' PA within sessions, allowing a more accurate evaluation of bouts of moderate- or vigorous-intensity PA.

The monetary reinforcement intervention in this study had some advantages. For one, it was not very costly, with the average amount paid per intervention session ranging from \$0.41 to \$1.35 across participants. The cost of this monetary reinforcement intervention is within the range of the cost of the token intervention implemented by Krentz et al. (2016) (\$0.59-\$1.74 per session). This finding adds to the literature on financial incentive interventions for health behaviors by showing that such an intervention can be effective at increasing PA with a novel population- adults diagnosed with ID. Using money rather than tangible reinforcers may be beneficial with this population. Less time and effort is required from those implementing the intervention, as the need for conducting ongoing preference assessments and purchasing tangible reinforcers is eliminated with the use of money as the reinforcer. The vast variety of backup reinforcers that money can buy may also make it more resistant to satiation effects, relative to tangible reinforcers or token reinforcement interventions with a more limited number of backup reinforcers. Finally, individuals with ID may have more opportunities to engage in life and social skills when purchasing goods or services with their money. The lower rating (average 3) in the

social validity questionnaire with the statement regarding continuing walking if they were not paid suggests that the monetary reinforcement may have been a necessary component of the intervention.

This study also showed that the intervention was implemented with high fidelity by a staff member at the facility, and that the higher rates of walking during intervention were maintained by the participants when the staff implemented the intervention. The staff member consistently completed all steps in the task analysis correctly except for one step which she missed on a few occasions- she did not remind each participant of the monetary contingency at the start of every session. Given the participants' history with the exchange contingency from their participation for several weeks, coupled with the display board outlining the contingency, the vocal reminder may not have been a critical component. The staff member's high treatment integrity, combined with the results of the staff social validity questionnaire support that adoption of the current intervention by facilities like the one in this study is feasible. The use of pedometers made the current intervention simpler and required less effort from the implementers than the intervention employed by Krentz et al. (2016) by eliminating the need to count laps and provide vocal feedback throughout the entire session. The monetary reinforcement intervention only took a few minutes of the implementer's time at the beginning and end of each session to collect data, hand out the pedometers, and pay participants when they returned the pedometers. This allowed the staff member who was implementing the program to continue to engage in her other work duties (e.g., she was observed responding to problem behavior, collecting data, and interacting with other clients, staff, and law enforcement) during the time that participants were walking. The added flexibility and low response effort may make this intervention appropriate in settings with limited staff availability.

There were some difficulties encountered throughout the course of the study. One issue encountered was participant absences from the LSD facility, particularly with Drew. Drew engaged in severe problem behavior (unrelated to the study) at several points during the second intervention phase that resulted in his absence from the facility for several days at a time. These absences resulting from problems with law enforcement are reflected in the missing data after his fourth session in the second intervention phase, and before staff implementation began. Although this participant had these problems outside of the study, his willingness to participate when he was present, combined with the results on the social validity questionnaire suggest he enjoyed participating in the study and that his behavioral issues were not related to his participation in the study.

Difficulties related to problem behavior were also encountered with John. At the end of the second baseline phase, John engaged in problem behavior outside of his participation in the study which resulted in a change in his level on the facility-wide level system. This change in level meant he could not go out on outings to the community, preventing him from buying things with the money he could earn. This may have served as an abolishing operation, decreasing the value of money as a reinforcer, potentially accounting for why his rate of walking did not increase during the second intervention phase. In fact, the only session during the second intervention where he engaged in a high rate of walking occurred on a day when his brother came to visit and was allowed to take him on a special outing. John dropped out of the study 2 days after the visit with his brother. The issues with John point to a potential limitation of using monetary reinforcement with individuals with ID. It is imperative that the individuals have access to several avenues for purchasing goods and services with the money they earn. If a facility has consumers with and without regular access to the community, a potential solution

could be to set up a store or commissary within the facility or allow opportunities for them to make purchases online. This may allow individuals with more restrictive support plans to participate in the same intervention as their peers who have more access to the community, as well as practice the life and social skills necessary to make purchases once they are in the community.

A limitation of the present study was that the effects of monetary reinforcement was not evaluated in the absence of self-monitoring. By sealing the pedometers during baseline, and uncovering them during intervention, the effects of self-monitoring and monetary reinforcement were not evaluated independent of each other. However, the purpose of this study was to evaluate a multi-component intervention including self-monitoring and reinforcement, in line interventions evaluated in previous research (e.g. Krentz et al., 2016; LaLonde et al., 2014). Future research could conduct component analyses to identify which components are necessary for increasing walking with this population.

Another issue encountered during this study was the varying session lengths because of the participants' different times of arrival and the facility schedule. This resulted in some sessions where the participants had substantially less time than usual to walk, meaning they could not earn the amount of money that they could during longer sessions even if they walked the entire time they were present. It is recommended that such an intervention is scheduled during a time when all participants can be present for the entire duration of the session.

Another limitation of this study was that data were only collected during the study sessions, which averaged 50 min, 5 days per week. If participants engaged in sufficient moderate- or vigorous-intensity PA during these sessions, it may be enough to infer that they are meeting the recommended PA levels. However, we did not measure PA that participants engaged

in outside of the sessions which may have also contributed towards meeting the recommended levels. Future research should measure PA throughout the entire day with the use of accelerometers or more advanced pedometers. Because pedometers like the one used in this study are more affordable, future studies can evaluate session-based interventions using pedometers, while also having participants wear accelerometers for the entire day to assess whether the session-based intervention results in increases in daily activity that meet recommended levels. Another limitation is that this study did not assess the long-term maintenance or sustainability of the monetary reinforcement intervention, something that should be evaluated by future research.

This study showed that self-monitoring and monetary reinforcement can be effective for increasing PA in adults diagnosed with ID. It also demonstrated that the simple and flexible monetary reinforcement intervention can be implemented correctly by staff member at the facility.

Study 2 - Method

The purpose of study 2 was to extend the findings from Study 1 by assessing a full-day self-monitoring and monetary reinforcement intervention for increasing walking in adults with ID.

Participants and Setting

Six men diagnosed with mild to moderate intellectual disability (ID) who attended a Life Skills Development (LSD) program participated in the study. Inclusion criteria for participants included: Being age 18-65, being diagnosed with mild to moderate ID (IQ scores ranging from 35-70), being ambulatory, being their own guardians, and answering “no” to all of the questions in the PA Readiness Questionnaire (PAR-Q) (see appendix A). The clinical director of the research site provided a pool of potential participants that she had observed to be the least active, from which the participants in the study were recruited. Jack was 27 years old and had diagnoses of intellectual disability and unspecified psychosis (IQ 55). Edward was 49 years old and had diagnoses of intellectual disability and nicotine dependency (IQ 52). Michael was 47 years old and had diagnoses of intellectual disability, anxiety disorder unspecified, and traumatic brain injury (IQ 58). Bernie was 48 years old and had diagnoses of intellectual disability, unspecified psychosis, unspecified mood disorder, nicotine dependency, and cerebral palsy (IQ 62). Andrew was 39 years old and had diagnoses of intellectual disability, (no IQ score on record) and anxiety disorder unspecified. Joe was 39 years old and had a diagnosis of intellectual disability (IQ 52).

Materials

Fitbit Alta™ was used to record participants' daily steps. The Fitbit Alta™ is a wrist-worn accelerometer which tracks daily steps taken, flights of stairs climbed, calories expended, and sleeping patterns. The Fitbit automatically reset the step count and other measures at midnight and recorded activity throughout the entire day.

Dependent Measures

The primary dependent measure in this study was the number of steps taken per day from Monday-Friday as recorded by the Fitbit Alta™. Participants wore the Fitbit Alta™ on their wrist throughout the entire day and night, and only removed them if they went swimming. Every weekday, the investigator met with the participants at the LSD to sync the devices to the online accounts. All of the data recorded by the Fitbit Alta™ are stored and graphed automatically on each user's account once it is synced. Data were collected Monday-Friday because participants did not attend the LSD on weekends and all lived in different residences making meeting on weekends impractical.

Interobserver Agreement

Because the steps recorded by the Fitbit Alta™ were automatically recorded and graphed in each participant's profile when synced, no interobserver agreement was measured.

Treatment Integrity

To assess the fidelity of implementation of the intervention by investigators, an observer recorded the number of steps in the treatment integrity checklist (see appendix E) completed correctly by the investigator and divided that by the total number of steps in the task analysis. Treatment integrity was assessed on 23% of intervention sessions and the average treatment integrity was 100 %.

Social Validity

Once the study was completed, four participants completed a social validity questionnaire to assess the acceptability of the intervention (see appendix D).

Experimental Design and Procedures

An ABAB reversal design, where A = Baseline, B = intervention, was used to evaluate the effectiveness of the intervention. A reversal design with simultaneous phase changes for all participants was used to prevent potential conflicts between participants that could arise from some having the ability to earn money while others did not. Across all phases of the study, participants wore the Fitbit Alta™ on their wrists during all hours, except when swimming. A contingency on wearing the Fitbit Alta™ and attending the LSD to sync their trackers, similar to the one used by Valbuena et al. (2015), was in place across all phases. Participants earned \$0.50 for every day that they wore the Fitbit for at least 10 hours and reported to the LSD to sync the data (up to \$2.50 per week, paid every Friday).

Baseline. During Baseline, participants wore the Fitbit Alta™ on their wrist at all times other than when they are showering or swimming. During this phase, the display on the Fitbit Alta™ was sealed with electrical tape to ensure that participants did not receive any feedback on the number of steps they walked. Participants met with the investigator at the LSD once a day, from Monday to Friday to sync the data from the Fitbit Alta™ to each participants' profile. There was no feedback or other programmed consequences for steps walked during this phase.

Intervention. During intervention, participants continued to wear the Fitbit Alta™ at all times, however the tape covering the display was removed to allow self-monitoring and open-loop feedback. To ensure that participants understood how the Fitbits worked, the investigator explained to participants that the device counted the steps as one walked and demonstrated the

concept by walking with a Fitbit on with an uncovered display. Participants were then allowed to wear an uncovered Fitbit Alta™ so they could see how the number went up as they took steps, and the researcher answered any questions they had about how the Fitbits worked. The researcher instructed participants that during this phase, they would earn \$0.25 for every 2,000 steps they walked each day. The researcher displayed a board that depicted the amount of money they could earn (in pictures of quarters and dollar bills) for every 2,000 steps they walked. To probe the participants' understanding of the contingency, the researcher provided participants with a notecard displaying a step count, mirroring the display on the Fitbit Alta™, ranging from 2,000 to 18,000 steps. The Fitbits displayed 1,000 steps as 1.0k, so the notecards displayed a values from 2.0k to 17.9k. Then participants were asked "how much would you earn if you walked these many steps?" Participants were required to independently answer three consecutive examples correctly before starting the intervention phase. This assessment was only conducted prior to implementation of the first intervention phase. Every weekday morning the investigators met with the participants to sync the Fitbit Alta™ and provide them the money they earned for the previous day's steps. The investigators brought up the previous day's step total in the participants' Fitbit profile on a mobile phone and showed them the step total. Then they were paid the amount they had earned based on the contingency, while the board with the amounts they could earn was displayed. After paying the participants for the previous days steps, the researcher reminded the participants of the contingency (\$0.25 for every 2,000 steps).

Study 2 Results

Figure 2 depicts the daily steps across all phases for all participants and Table 2 summarizes the average daily steps for each phase and the money earned during intervention for each participant. The first intervention phase resulted in a noticeable increase in the mean daily steps for only two participants, Edward and Michael. Two participants, Jack and Bernie experienced very slight increases in mean daily steps during the first intervention, although there was a noticeable decrease in days with very low step counts for these two participants. The final two participants, Andrew and Joe, experienced noticeable decreases in their mean daily step counts from baseline to the first intervention phase. During the return to baseline, Edward and Michael's mean daily steps decreased, however they did not reach levels as low as they had during the initial baseline phase. Bernie's daily steps decreased slightly to levels like those of the initial baseline. Jack experienced a mean decrease to a lower mean daily step count than he had during the first intervention. Andrew's mean daily steps decreased slightly when the intervention was removed. Joe dropped out of the study prior to the return to baseline. After he temporarily misplaced his Fitbit and missed several days of data collection, and eventually losing his Fitbit, it was decided he would not continue in the study given his already high daily steps during baseline and the first intervention phase. During the second intervention phase, Jack's mean daily steps increased very slightly, but not as high as during the initial intervention phase. Edward and Michael both had increases in their mean daily steps during the final intervention phase to levels similar to those of the first intervention phase. Bernie's mean daily steps slightly decreased during the second intervention phase. Finally, Andrew experienced a noticeable increase in his

mean daily steps during the final intervention phase, to levels similar to his first baseline phase. Experimental control was only demonstrated through Edward's replication of treatment effects. Although experimental control was not demonstrated with Michael as his daily steps did not decrease during the second baseline phase, his high average step counts during intervention phases may have been clinically significant. For the remaining participants, the whole-day self-monitoring and monetary reinforcement intervention did not substantially increase the daily steps walked.

The results of the participant social validity questionnaires suggest that the intervention was perceived as effective by the participants and that the intervention had high acceptability. On a rating scale from 1 (strongly disagree) to 5 (strongly agree) the participants' answers averaged: 4.5 (range 3-5) for "I walk more now than I did before the walking program;" 5 for "I enjoyed the walking program;" 4.5 (range 4-5) for "I will keep walking more now that the program is over;" and 2.5 (range 2-4) for "I will not continue walking more if I do not receive money for it." Additionally, several participants reported enjoying having the Fitbit, earning and tracking money, and getting stronger in response to an open-ended question about what they liked about the program. In response to an open-ended question about what they disliked about the program, two participants said there was nothing they didn't like, one participant said that he disliked that we kept the bracelets (Fitbits), and one participant said he did not want to do jogging.

Study 2 Discussion

Study 2 evaluated an intervention similar to the one implemented in Study 1, with the modification of being whole-day rather than session-based. The whole-day self-monitoring and monetary reinforcement intervention substantially increased the daily steps of only two of the six participants (Edward and Michael), with the treatment effects being replicated for only one participant (Edward). The data for all participants were highly variable, as is commonly the case in studies assessing whole-day PA (Valbuena et al., 2016). There is also substantial overlap across phases for all participants, making the interpretation of effects difficult. Figure 2 includes mean lines to facilitate visual inspection, but even through inspection of phase means, the intervention only produced noticeable increases in walking for Edward and Michael. The increases in activity for these two participants may have been clinically significant, as they both exceeded an average of 10,000 steps per day during both intervention phases, a daily step count that is associated with the recommended activity levels (Tudor-Locke & Basset, 2004). Additionally, the cost of the intervention for Edward and Michael, who responded to the intervention, was only \$1.17 and \$1.58 per day, comparable to the cost of the intervention in Study 1 and in Krentz et al. (2016). Future studies could identify variables, such as cognitive level which may make some individuals more responsive to the whole-day intervention.

Despite the increases in walking for Edward and Michael, the intervention failed to produce meaningful increases in PA for the remaining participants. There are several factors which may have contributed to the lack of intervention effects. One variable which may have influenced the effectiveness of the intervention was the contingency for wearing the Fitbit and

showing up to sync the Fitbits (\$0.50 per day). Because this contingency was in place during intervention sessions, the participants were earning money daily regardless of how much they were walking. This may have functioned as an AO, decreasing the value of money that could be earned by walking. A potential solution for future studies could be to remove the contingency for wearing the Fitbit during intervention, as unlike during baseline, there could be motivation for wearing it to earn money for steps walked. Another solution could be to use a different reinforcer than money for the wearing contingency, so that it does not compete with the contingencies for walking. This conclusion is supported by the fact that the four participants who did not respond to the intervention earned more from the wearing contingency than they did from the steps walked during intervention, whereas for Edward and Michael it was the opposite (see Table 2).

Another variable that may have made the whole-day intervention less effective with this population is the lack of structure and clear opportunities to engage in PA. In Study 1 as in Krentz et al. (2016), we implemented interventions during sessions lasting approximately one hour. The presentation of the pedometers and instructions at the start of sessions in Study 1, and the lap set up and instructions at the start of the study in Krentz et al. may have served as prompts to engage in walking, particularly during intervention where participants were reminded that reinforcement contingencies were in place for walking. Additionally, in these two session-based studies, the session presented a clear opportunity where participants were only expected to engage in PA, potentially minimizing competing contingencies. In contrast, the whole-day intervention in this study lacked such structure. The participants met the investigators in the morning to receive the money from the previous day, and immediately after the meeting they left for scheduled activities including work, outings, board games, and arts and crafts. Unlike study 1, where participants were presented with a scheduled opportunity to engage in walking

following the description of the contingency, the participants in study 2 would have had to independently schedule or initiate going for walks later to increase their step counts. Given that there were no programmed prompts or reminders throughout the day, the participants may have lacked the skills to schedule their own time to go for walks. It is also unknown whether the participants in this study engaged in self-monitoring of their steps throughout the day. Although collecting data on self-monitoring (how often the participants check their step counts throughout the day) would not be feasible, incorporating prompts to engage in self-monitoring throughout the day may increase the likelihood that all participants are monitoring their step counts. Prompts to check their step counts, combined with reminders about the monetary contingency may improve the effectiveness of similar interventions with this population. The prompts can be delivered by a trained staff member, through cell phones, or through activity monitors with more advanced displays.

There were some limitations encountered throughout the course of this study. Although participants were instructed to wear the Fitbits at all times unless they were going to be submerged, all participants missed days of data collection because they took off their Fitbits and forgot to put them back on. Out of the 79 possible days of data collection, Jack, Edward, Michael, Bernie, Andrew, and Joe wore their Fitbits on 66, 74, 61, 65, 76, and 15 days respectively. In addition to data missing from forgetting to wear the Fitbits, several participants lost their Fitbits throughout the course of the study and needed replacements. The inability to ensure that participants were wearing the activity trackers during the entire observation period (24-hours), or to provide prompts to put them on if they were taken off is another limitation of whole-day interventions relative to session-based interventions.

Another limitation of this study was that on some occasions, participants were not present at the LSD because of reasons outside of their control (lack of transportation or other scheduled activities such as therapy that took precedent over participation in the study). During baseline phases this was less problematic as the data could be obtained the following day, and participants were not receiving feedback on the steps they walked. However, during intervention phases if participants were not present at the LSD for the meeting, they would have to wait until the following day to receive the money from the two previous days (and in some occasions more than two consecutive days). This resulted in an even more delayed delivery of reinforcement for steps walked several days prior. Session-based interventions like the one in Study 1 allow for delivery of reinforcement immediately following the participants PA behavior.

General Discussion

These two studies sought to extend the literature on increasing PA in individuals with ID by evaluating simple, easy-to-implement interventions that could be implemented by staff members. It also adds to the monetary contingency management literature by evaluating monetary contingency management for PA with a novel population.

Study 1 established the efficacy of using monetary reinforcement for increasing walking in adults with ID during a daily 1-hr time slot set aside for this activity. The intervention in Study 1 produced increases in the rate of walking for all five participants, with replications of the treatment effects for four of the five. The intervention in Study 1 increased the average rate of walking to above 100 steps/min, levels that are in range with the USDHHS (2008) recommendations during both intervention phases for two participants, and during one phase for two additional participants. Furthermore, all participants experienced increases in their average rate of walking during intervention phases even during the remaining intervention phases that did not exceed an average of 100 steps/min. In addition to increasing the rate of walking for all participants, Study 1 demonstrated that a staff member at the facility implemented the intervention correctly following minimal training, and the higher rates of walking were maintained when the staff member took over implementation.

Study 2 evaluated a whole-day self-monitoring and monetary reinforcement intervention. Studies on increasing PA with individuals with disabilities had focused on session-based interventions (e.g. Bennet et al., 1989; Krentz et al., 2016; Todd & Reid, 2006) except for LaLonde et al. (2014) which evaluated an intervention consisting of goal setting and

reinforcement to increase the steps walked by young adults with autism during the 6 hours they attended a training program. Study 2 extended the literature by evaluating an intervention which measured activity during the entire day. The intervention in Study 2 produced detectable increases in walking for only two out of the six participants.

Given the greater effectiveness of the session-based intervention in Study 1, future studies to increase PA with individuals with disabilities should consider session-based interventions. Session-based interventions present a clear opportunity for participants to engage in activity with fewer competing contingencies. It also facilitates the delivery of prompts and allows for delivery of reinforcement immediately after the participants engage in PA. Finally, session-based studies allow investigators to track the equipment and ensure it is returned, preventing costly losses associated with misplaced Fitbits. Future research should use accelerometers like the Fitbits from study 2 to obtain a more detailed record of participants' PA within session, which may make it easier to determine if they engaged in bouts of sufficiently intense activity to meet recommended levels (Tudor-Locke et al., 2008; USDHHS, 2008).

A limitation of both studies is that because of the covered pedometers and Fitbits during baseline, both interventions introduced multiple components at once (self-monitoring and monetary reinforcement). Although there is precedent for covering activity monitors during baseline when evaluating multi-component interventions (e.g. LaLonde et al, 2014; Normand, 2008; Valbuena et al., 2015), doing this make it impossible to evaluate the individual effects of self-monitoring and monetary reinforcement. Krentz et al. (2016) included the self-monitoring component during baseline (investigator spoke out the lap number as participants completed each lap), allowing for the evaluation of the effects of the reinforcement component in isolation.

Future studies could employ baselines with uncovered pedometers or accelerometers to differentiate the effects of self-monitoring and reinforcement.

Another limitation in this study is that we cannot compare the effects of session-based reinforcement and whole day reinforcement because we did not evaluate both interventions with the same participants. Because participants in study 1 were different from participants in study 2, we do not have a direct, within-subjects comparison of these two procedures. It is possible that differences in participants contributed to differences in the results of the two procedures. This limitation notwithstanding, we did demonstrate with two different groups of participants that session-based intervention was effective and that the whole day intervention was not. Future research should be designed for a direct comparison of the procedures to better establish their relative effectiveness.

Given the potential positive health and behavioral outcomes related to increasing PA (CDC, 2015d; Lang et al., 2010), the interventions in these studies presents a potential strategy to promote PA in similar facilities for adults with ID. In addition to implementing the intervention with fidelity, the staff member from Study 1 rated the intervention as highly acceptable. The use of activity monitoring technology like pedometers and Fitbits for monetary reinforcement interventions provide several advantages. The use of pedometers in Study 1 allowed the staff member to engage in her work activities during the session. The use of money as a reinforcer eliminates the need for staff to purchase backup reinforcers like those used in token systems (e.g. Krentz et al., 2016) saving time and money. Additionally, as a generalized conditioned reinforcer, money can be more resistant to satiation effects, while providing the participants with opportunities to engage in life and social skills while purchasing goods and services in their community. Finally, the interventions in both studies had high social validity, as they were rated

with high acceptability by all participants, with emphasis on them enjoying the opportunity to earn money. Future research should analyze the costs and benefits of financial incentive interventions for increasing PA in individuals with ID such as the one described in these studies, as well as identify potential funding sources.

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Table 1
Summary of earnings and average steps/min with ranges across all phases for all participants

Participant	Baseline1 Average Steps/Min (Range)	Intervention 1 Average Steps/Min (range)	Baseline 2 Average Steps/Min (range)	Intervention 2 Experimenter Implemented Average Steps/Min (range)	Staff- Implemented Intervention Average Steps/Min (range)	Total Amount earned (\$)	Average Amount Earned (\$/Day)
Stan	64.6 (11.6-110.9)	108.7 (102.1-116.1)	40.8 (18.5-76.4)	112.8 (90.9-118.4)	113.2 (103.9-116.7)	\$42	\$1.35
Drew	3.8 (0-15.3)	83.2 (0-106)	7.9 (0.2-21.9)	59.4 (8.4-107.3)	104 (104)	\$11.75	\$0.84
Eric	14.7 (0.8-42.8)	103.6 (83.7-124.8)	11.1 (9.3-12.4)	71.8 (33-94.7)	81 (24.8-110.7)	\$21.50	\$0.83
John	10.5 (1.2-31.4)	57.5 (0-105.3)	5.5 (0.7-9.7)	18.76 (0-106.7)	N/A	\$6.50	\$0.41
Alex	51.4 (18.1-80.7)	108.1 (88.8-119.1)	25.8 (0-72)	115 (106.3-126)	110.9 (89-117.8)	\$30.75	\$1.23

Table 2

Summary of earnings and average daily steps across all phases for all participants

Participant	Baseline1 Average Steps/Day	Intervention 1 Average Steps/Day	Baseline 2 Average Steps/Day	Intervention 2 Average Steps/Day	Total Amount Earned During Intervention (\$)	Average Amount Earned During Intervention (\$/Day)	Total Amount Earned from Wearing Contingency (\$)
Jack	8,202	8,524	6,829	7,212	\$30.75	\$0.85	\$33.00
Edward	7,133	10,078	8,257	10,410	\$42.25	\$1.17	\$37.00
Michael	8,267	13,249	11,436	13,744	\$49.00	\$1.58	\$30.50
Bernie	6,586	7,628	6,849	6,265	\$22.75	\$0.76	\$32.50
Andrew	9,412	6,352	5,386	9,633	\$35.25	\$0.90	\$38.00
Joe	13,086	11,400	N/A	N/A	\$5.00	\$1.25	\$7.50

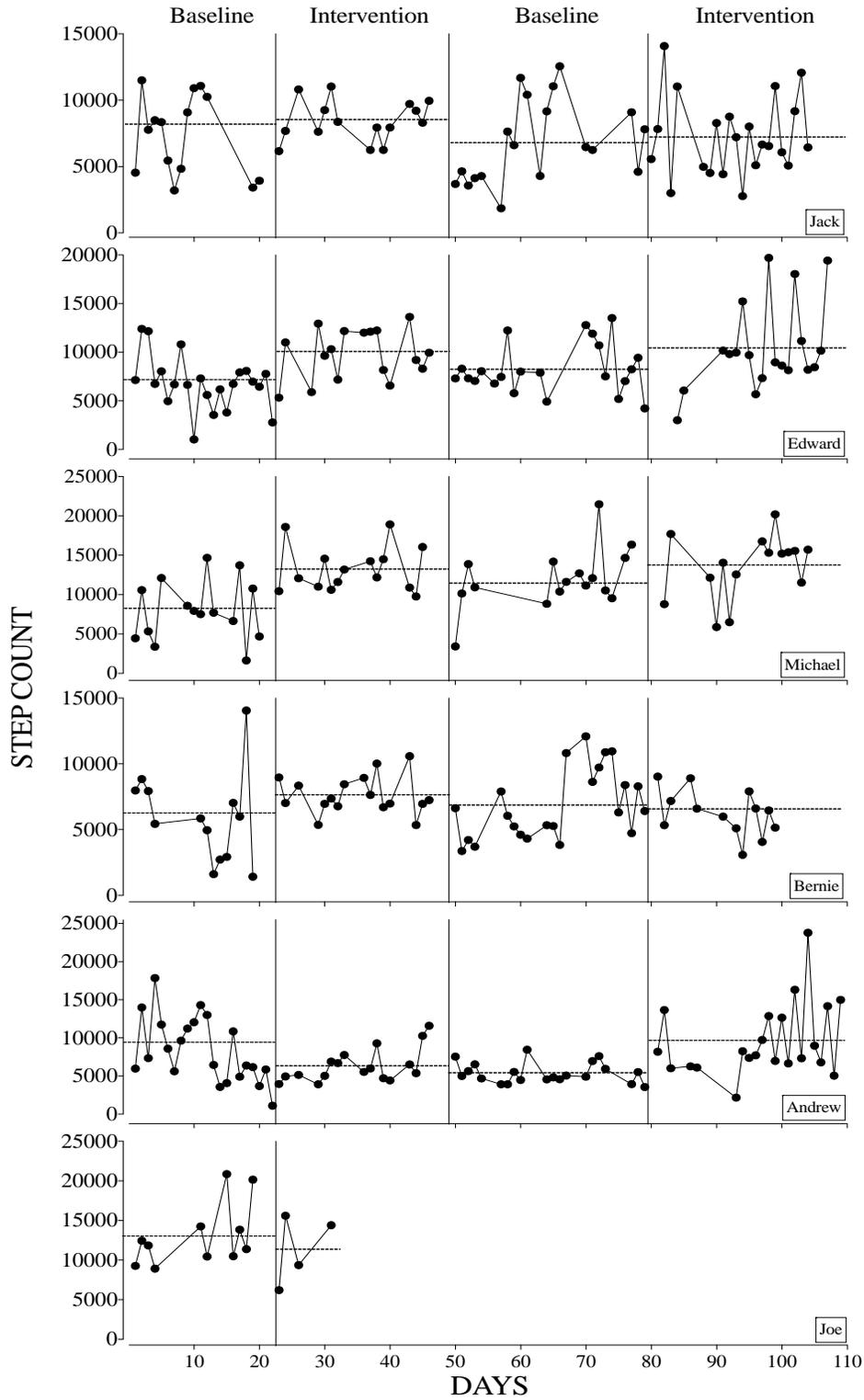


Figure 2. Steps per day across all phases for all participants in Study 2. Dashed horizontal lines depict mean step counts for each phase.

Appendices

Appendix A: Physical Activity Readiness Questionnaires

Regular PA is fun and healthy, and increasingly more people are starting to become more active every day. Being more active is very safe for most people. However, some people should check with their doctor before they start becoming much more physically active.

If you are planning to become much more physically active than you are now, start by answering the seven questions in the box below. If you are between the ages of 15 and 69, the PAR-Q will tell you if you should check with your doctor before you start. If you are over 69 years of age, and you are not used to being very active, check with your doctor.

Common sense is your best guide when you answer these questions. Please read the questions carefully and answer each one honestly: answer YES or NO.

- 1. Has your doctor ever said that you have a heart condition and that you should only do PA recommended by a doctor?**
- 2. Do you feel pain in your chest when you do PA?**
- 3. In the past month, have you had chest pain when you were not doing PA?**
- 4. Do you lose your balance because of dizziness or do you ever lose consciousness?**
- 5. Do you have a bone or joint problem (for example, back, knee or hip) that could be made worse by a change in your PA?**
- 6. Is your doctor currently prescribing drugs (for example, water pills) for your blood pressure or heart condition?**
- 7. Do you know of any other reason why you should not do PA?**

Appendix B: Study 1 Treatment Integrity Task Analysis

Step	Check if Completed
Open all pedometer displays	
Press “Reset” button until step count resets to zero on all pedometers	
Close all pedometers	
Place display board in area visible to participants	
Remind all participants that they will earn \$0.25 for every 1,000 steps they take, and point their attention to the display board	
Provide each participant with their assigned pedometer	
Note start time of session	
Do not provide additional instructions or feedback (e.g. no encouragement or praise) related to walking throughout the session. (It is ok to assist participants with checking their current step counts)	
At end of session (approximately one hour), call participants over to display board	
Note end time of session	
Calculate duration of session and record on data sheet	
Take back each participant’s pedometer and open the display	
Record each participants step count for the session on the data sheet	
Give each participant \$0.25 for every 1,000 steps recorded by the pedometer during the session (according to display board)	
Total steps completed correctly	/14

Appendix C: Study 1 Staff Social Validity Questionnaire

Please circle the response that best matches your agreement with the following statements about your experience with this research study.

1. The intervention was not too time-consuming and easy to implement.

Strongly Agree 5	Agree 4	Neutral 3	Disagree 2	Strongly Disagree 1
----------------------------	-------------------	---------------------	----------------------	-------------------------------

2. We should continue to implement this intervention now that the study is complete.

Strongly Agree 5	Agree 4	Neutral 3	Disagree 2	Strongly Disagree 1
----------------------------	-------------------	---------------------	----------------------	-------------------------------

3. This walking intervention is appropriate and sustainable with our current resources.

Strongly Agree 5	Agree 4	Neutral 3	Disagree 2	Strongly Disagree 1
----------------------------	-------------------	---------------------	----------------------	-------------------------------

4. I believe the participants engage in more PA now than before participating in this study.

Strongly Agree 5	Agree 4	Neutral 3	Disagree 2	Strongly Disagree 1
----------------------------	-------------------	---------------------	----------------------	-------------------------------

5 I believe it is appropriate to use monetary rewards for helping participants increase their PA.

Strongly Agree 5	Agree 4	Neutral 3	Disagree 2	Strongly Disagree 1
----------------------------	-------------------	---------------------	----------------------	-------------------------------

6. I feel confident in my ability to implement the program on my own.

Strongly Agree 5	Agree 4	Neutral 3	Disagree 2	Strongly Disagree 1
----------------------------	-------------------	---------------------	----------------------	-------------------------------

7. Did you have any issues or difficulties implementing the intervention?

8. What parts of the program did you find most helpful?

9. What aspects of the program did you not like?

10. Would you continue to use it or recommend it to other service providers?

Appendix D: Participant Social Validity Questionnaire

1. I walk more now than I did before the walking program.

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
1	2	3	4	5

2. I enjoyed the walking program.

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
1	2	3	4	5

3. I will keep walking more now that the program is over.

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
1	2	3	4	5

4. I will not continue walking more if I do not receive money for it.

Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
1	2	3	4	5

5. What did you like about the program?

6. What did you not like about the program?

Appendix E: Study 2 Treatment Integrity Checklist

Session Date: _____ Implementer: _____ Observer: _____

Please identify whether or not the implementer completed the steps listed below for each of the participants by placing a “✓” if the step was completed or an “X” if the step was not completed.

Participant #	Appropriate Step Count Obtained?	Correct Amount of Money Provided?	Contingency Visual Displayed?
1			
2			
3			
4			
5			
6			

Appendix F: IRB Documents



RESEARCH INTEGRITY AND COMPLIANCE
Institutional Review Boards, FWA No. 00001669
13901 Bruce B. Downs Blvd., MDC035 • Tampa, FL 33612-4799
(813) 974-5638 • FAX (813) 974-7091

July 28, 2017

Diego Valbuena, B.S.
ABA-Applied Behavior Analysis
13301 Bruce B Downs Blvd.
MHC 2113A
Tampa, FL 33612

RE: **Expedited Approval for Initial Review**

IRB#: Pro00030772

Title: Monetary reinforcement for Increasing Daily Steps Walked in Adults with Intellectual Disabilities

Study Approval Period: 7/27/2017 to 7/27/2018

Dear Mr. Valbuena:

On 7/27/2017, the Institutional Review Board (IRB) reviewed and **APPROVED** the above application and all documents contained within, including those outlined below.

Approved Item(s):

Protocol Document(s):

[Pro00030722_v1_06.26.17](#)

Consent/Assent Document(s)*:

[Adult Consent Form_v1_7.24.17.pdf](#)

*Please use only the official IRB stamped informed consent/assent document(s) found under the "Attachments" tab. Please note, these consent/assent documents are valid until the consent document is amended and approved.

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

research through the expedited review procedure authorized by 45CFR46.110. The research proposed in this study is categorized under the following expedited review category:

- (5) Research involving materials (data, documents, records, or specimens) that have been collected, or will be collected solely for nonresearch purposes (such as medical treatment or diagnosis).
- (6) Collection of data from voice, video, digital, or image recordings made for research purposes.
- (7) Research on individual or group characteristics or behavior (including, but not limited to, research on perception, cognition, motivation, identity, language, communication, cultural beliefs or practices, and social behavior) or research employing survey, interview, oral history, focus group, program evaluation, human factors evaluation, or quality assurance methodologies.

As the principal investigator of this study, it is your responsibility to conduct this study in accordance with IRB policies and procedures and as approved by the IRB. Any changes to the approved research must be submitted to the IRB for review and approval via an amendment. Additionally, all unanticipated problems must be reported to the USF IRB within five (5) calendar days.

We appreciate your dedication to the ethical conduct of human subject research at the University of South Florida and your continued commitment to human research protections. If you have any questions regarding this matter, please call 813-974-5638.

Sincerely,



Kristen Salomon, Ph.D., Vice Chairperson
USF Institutional Review Board



RESEARCH INTEGRITY AND COMPLIANCE
Institutional Review Boards, FWA No. 00001669
13901 Bruce B. Downs Blvd., MDC035 • Tampa, FL 33612-4799
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10/7/2016

Diego Valbuena, B.S.
ABA-Applied Behavior Analysis
13301 Bruce B Downs Blvd.
MHC 2113A
Tampa, FL 33612

RE: **Expedited Approval for Initial Review**

IRB#: Pro00027847

Title: Monetary Reinforcement for Increasing Walking in Adults with Intellectual Disabilities

Study Approval Period: 10/5/2016 to 10/5/2017

Dear Dr. Valbuena:

On 10/5/2016, the Institutional Review Board (IRB) reviewed and **APPROVED** the above application and all documents contained within, including those outlined below.

Approved Item(s):

Protocol Document(s):

[Pro00027847_vers1_9.11.16](#)

Consent/Assent Document(s)*:

[Adult Consent Form \(Staff\)_v2_10.03.16.pdf](#)

[Adult Consent Form_v2_10.03.16.pdf](#)

*Please use only the official IRB stamped informed consent/assent document(s) found under the "Attachments" tab. Please note, these consent/assent document(s) are only valid during the approval period indicated at the top of the form(s).

It was the determination of the IRB that your study qualified for expedited review which includes activities that (1) present no more than minimal risk to human subjects, and (2) involve only procedures listed in one or more of the categories outlined below. The IRB may review research through the expedited review procedure authorized by 45CFR46.110 and 21 CFR

56.110. The research proposed in this study is categorized under the following expedited review category:

(4) Collection of data through noninvasive procedures (not involving general anesthesia or sedation) routinely employed in clinical practice, excluding procedures involving x-rays or microwaves. Where medical devices are employed, they must be cleared/approved for marketing.

(7) Research on individual or group characteristics or behavior (including, but not limited to, research on perception, cognition, motivation, identity, language, communication, cultural beliefs or practices, and social behavior) or research employing survey, interview, oral history, focus group, program evaluation, human factors evaluation, or quality assurance methodologies.

As the principal investigator of this study, it is your responsibility to conduct this study in accordance with IRB policies and procedures and as approved by the IRB. Any changes to the approved research must be submitted to the IRB for review and approval via an amendment. Additionally, all unanticipated problems must be reported to the USF IRB within five (5) calendar days.

We appreciate your dedication to the ethical conduct of human subject research at the University of South Florida and your continued commitment to human research protections. If you have any questions regarding this matter, please call 813-974-5638.

Sincerely,



Kristen Salomon, Ph.D., Vice Chairperson
USF Institutional Review Board