5-2017

Evaluating the Effects of Wearable Technologies to Improve Physical Activity Levels for College Students with Intellectual and Developmental Disabilities

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I am submitting herewith a dissertation written by Kelly Nicole Kraiss entitled "Evaluating the Effects of Wearable Technologies to Improve Physical Activity Levels for College Students with Intellectual and Developmental Disabilities." I have examined the final electronic copy of this dissertation for form and content and recommend that it be accepted in partial fulfillment of the requirements for the degree of Doctor of Philosophy, with a major in Education.

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Evaluating the Effects of Wearable Technologies to Improve Physical Activity Levels for College Students with Intellectual and Developmental Disabilities

A Dissertation Presented for the

Doctor of Philosophy

Degree

The University of Tennessee, Knoxville

Kelly Nicole Kraiss

May 2017

Dedication

For my past students, who have made me into the person I am today…

For my current students, who have inspired me and given me purpose…

For my future students, who will change the world …

This is for you.

Acknowledgements

I am beyond grateful for the amazing amount of support and love that I have received throughout the course of my doctoral program and, especially, during the last two years of comps, prospectus, and dissertation. I have grown immensely as an individual and as a professional over the last four years and there is no way that I could have done any of this without the support of so many people. Of course, I need to thank God first – for putting the desire in me to start and finish this program, for giving me the drive to work as hard as I have, and for always showing me that His plan is much better than my own.

I will start with my family. To know that I have your full, unconditional support every day even from so far away means more than I could ever possibly say. I would not be half the person I am today if it were not for the values that you instilled in me and for the belief that you have always had in me. Thank you for encouraging me to pursue whatever crazy ideas have been on my heart, time and time again, for always being a phone call away, and for never letting me forget where HOME is. Mom, Dad, and Lacy - you guys are the best parents and best sister I could have ever asked for.

Thank you, too, to so many individuals who have encouraged me along the way. To my aunt Carol, thank you for your own commitment to special education and for inspiring me to make a difference in the same way. To Elisa, Elizabeth, and Cassie: thank you for endless laughs when I needed them, for never being more than a text away, and for reminding me that people are always the most important. To Alli and Brent, thank you for changing my view of success and for encouraging me to finish what I had started when I wanted to quit. To Bianca and my coaching family, thank you for inspiring me and supporting me. To my Facebook family, thank you for following and caring about my journey through school, fitness, life, and love. To the rowers I am lucky enough to coach, thank you for making me smile every afternoon and for making me a better teacher. Lastly, thank you to Ricky for showing up and for supporting all of me more than I had any idea was possible.

Finally, a huge thank you to my committee of Dr. David Cihak, Dr. Maribeth Coleman, Dr. Tara Moore, and Dr. Dawn Coe. Your 100% support of and belief in my doing something completely out of the ordinary but completely in line with my greater life passion and purpose means the world to me. Thank you for your feedback, for your expertise, and for your patience. I would especially like to thank Dr. David Cihak for believing in me and in what I am doing, for being so patient with all of my other commitments, for helping me do whatever it was that I needed, and for asking me to work with the FUTURE program in the first place. To be able to combine my two loves - fitness and special education - has truly been a dream for me. It has been a unique, rewarding opportunity, and not one that I take for granted or take lightly. I am looking forward to continuing my work in this field and making an impact however I can.

“Let us not become weary in doing good,
for at the proper time we will reap a harvest
if we do not give up.”
- Galatians 6:9

Abstract

Regular physical activity can decrease the likelihood of being overweight or obese as well as other negative health outcomes. Adults with intellectual and developmental disabilities (I/DD) are more likely to be obese, less likely to be physically active, and at greater risk for health conditions and disease. Thus, there is a need for interventions that aim to increase the physical activity levels of adults with I/DD. However, interventions and related research in this field are limited. The purpose of this dissertation was to examine two independent single-subject design interventions that incorporated the use of wearable technology, a Fitbit, in order to improve physical activity levels of young adults with I/DD. Chapter 1 provided an overview of the theoretical foundations behind motivation, in particular, self-determination theory, as well as how it is related to fitness and physical activity. Common barriers that people with I/DD face when participating in physical activity are explored, as well as, self-management as a strategy for increasing physical activity. Chapter 2 evaluated the effects of a goal-setting intervention on the physical activity levels of college students with I/DD. It was implemented as a part of a single-subject changing criterion design, where students set step count goals for each phase based on previous averages. Results indicated that participants consistently increased the number of steps taken across consecutive phases and were able to achieve greater consistency in step counts over time. Chapter 3 examined the effects of a social reinforcement intervention via a single-subject withdrawal/reversal design on the activity levels of college students with I/DD as measured by daily steps. This intervention incorporated social reinforcement by peer mentors within the Fitbit app. The intervention was effective, as all participants increased average step counts during intervention weeks. Chapter 4 discussed results of both studies as they pertain to the current literature on wearable technology to improve activity levels, self-management and goal setting in relation to health, fitness, and physical activity, and social reinforcement in physical activity for people with I/DD. Conclusions are discussed within the framework of self-determination theory. Limitations, implications, and recommendations for future research are also presented.

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Chapter 1

Understanding Physical Activity within the Context of Self-Determination Theory for Individuals with Intellectual and Developmental Disabilities

Problem Statement

Obesity has become a common problem in the United States, with over one third of American adults being classified as obese (United States Centers for Disease Control and Prevention (CDC), 2014). In adults with intellectual and/or developmental disabilities (I/DD), the prevalence of obesity is even higher than in the general population; 38.3% of adults with I/DD are obese compared to 28% of adults without I/DD who are obese (Hsieh, Rimmer, & Heller, 2014). Morbid obesity is also more prevalent in adults with I/DD than it is in those without (7.4% vs. 4.2%), and women with I/DD and individuals with Down Syndrome are even more likely to be obese (Bodde et al., 2013; Hsieh et al., 2014; Rimmer & Yamaki, 2006).

It is well known that obesity can be prevented and healthy weight can be maintained through physical activity (CDC, 2014). National physical activity guidelines recommend that adults participate in regular physical activity, which means at least 150 minutes per week of moderate intensity activity or 75 minutes per week of vigorous intensity activity (U.S. Department of Health and Human Services, 2008). The guidelines indicate that physical activity can play a role in preventing a number of negative health outcomes, and the recommendations and benefits are the same for people with and without I/DD.

However, in individuals with I/DD, decreased physical activity and inactivity are far more common than in the general population. A number of researchers have investigated the differences between individuals with I/DD and the general population in terms of activity level. Blick, Saad, Goreczny, Roman, and Sorenson (2015) found that less than one third of their sample (individuals with I/DD who received funding from Pennsylvania's Office of Developmental Programs) reported regular exercise, and almost half of the sample reported never exercising. A North Carolina study compared health data of people with I/DD with that of people without I/DD and found that adults with I/DD were significantly more likely to have a sedentary lifestyle than those without; in fact, one third of their sample had no exercise within the past month (Havercamp, Scandlin, & Roth, 2004). The literature is clear that individuals with I/DD engage in either far less than the recommended amount of physical activity or no physical activity at all (e.g., Barnes, Howie, McDermott, & Mann, 2013; Bodde, Seo, Frey, Van Puymbroeck, & Lohrmann, 2012a; Borremans, Rintala, & McCubbin, 2010; Esposito, MacDonald, Hornyak, & Ulrich, 2012; Finlayson, Turner, & Granat, 2011; MacDonald, Esposito, & Ulrich, 2011; Peterson, Janz, & Lowe, 2008; Stanish & Draheim, 2005).

Purpose and Organization

This dissertation, comprising four chapters, examines the effect of the use of wearable technology on physical activity levels of college students with intellectual and developmental disabilities (I/DD) via two separate interventions. Chapter 1 articulates theoretical foundations of motivation as well as how motivation is related to fitness and physical activity. It defines fitness and how it is measured in individuals with I/DD, as well as identifies common barriers to participation in physical activity by this population. Chapter 1 also examines the foundations of self-management for people with I/DD and the literature for ways that self-management strategies can be used to increase physical activity. Chapter 2 reviews the first study of this two-study dissertation and was conducted and evaluated independently of the second intervention. Chapter 2 examines the effects of a goal-setting intervention on students' physical activity levels as measured by a wearable device (the Fitbit Blaze). Chapter 3 reviews the second study of this two-study dissertation and was conducted and evaluated independently of the first. This study examines the effect of an intervention incorporating social reinforcement within the Fitbit app on participants' physical activity levels. Chapter 4 discusses findings and implications from both studies. Results are discussed within the context of the current literature on wearable technology, self-management, goal setting, and social reinforcement in physical activity, as well as how they pertain and apply to self-determination theory.

Research Questions

Study 1. The purpose of this study was to examine the effects of a goal-setting intervention using Fitbit wearable devices on the physical activity level of college students with I/DD. Specific research questions included:

1. What are the effects of goal-setting sessions using Fitbit devices on the physical activity level of college students with I/DD?
2. Do college students with I/DD find value in incorporating goal-setting interventions into the use of a Fitbit device?

Study 2. The purpose of this study was to examine the effects of app-based social reinforcement on the physical activity levels of college students with I/DD. Specific research questions included:

1. What are the effects of app-based social reinforcement on the physical activity levels of college students with I/DD?
2. Do college students with I/DD find value in incorporating public encouragement challenges into the use of a Fitbit device?

Theoretical Foundations

There are a number of theories often applied to exercise science; one is the broad theory of motivation. Generally speaking, motivation is the act of being moved to do something, or having the impetus or inspiration to act. It is a key topic in psychology, as it pertains and applies to all aspects of human activation and intention (Ryan & Deci, 2000a, 2000b). When studying motivation, there are two specific aspects of behavior to be considered: energization and direction (Deci & Ryan, 1985a). More simply, it studies *why* humans engage in certain behaviors; it looks at an individual's needs and the processes that relate those needs to behaviors. In other words, the theory of motivation views behavior as the result of an individual's mental processes (Bolles, 1967).

While some theories see motivation as an issue of volume or amount (i.e., an individual has very little or a great deal of motivation), a more in-depth study of motivation indicates that there are varying factors that move different individuals to act. This means that people can vary in both the amount or level of motivation as well as in the orientation, or the type, of the motivation (Ryan & Deci, 2000a, 2000b). What moves one individual to act may not move a second individual to act, or to act in the same manner.

The literature has organized two different approaches to motivation: the organismic approach and the mechanistic approach (Deci & Ryan, 1985a). In the mechanistic approach, humans are seen as passive; instead of making decisions, they are "pushed around by the interaction of physiological drives and environmental stimuli" (p. 3). The organismic approach, on the other hand, views humans as active, volitional beings that initiate behaviors. Stimuli are not seen as the causes of behavior, yet they give the individual opportunities to satisfy its needs.

Self-Determination Theory

One approach to the broad theory of motivation is self-determination theory (SDT). It approaches motivation from an organismic standpoint and addresses a variety of psychological issues, including self-regulation, goals and goal setting, the impact that social environments have on behavior, and a wide range of life domains. It is most often used in applied fields such as sports and education (Deci & Ryan, 2008).

Basic Needs Theory

At its most basic level, SDT acknowledges that there are three universal human needs which must be satisfied in order for an individual to be self-determined; those needs are autonomy, competence, and relatedness. Deci and Ryan (2000) explain that the satisfaction (or non-satisfaction) of these basic psychological needs is related to the degree to which individuals pursue and reach their goals. They further clarify that we cannot fully comprehend goal-directed behavior without addressing these three underlying needs of competence, autonomy, and relatedness.

Often referred to as "psychological nutriments" within SDT, these three needs are "essential for ongoing psychological growth, integrity and well-being" (Deci & Ryan, 2000, p. 229). SDT hypothesizes that an individual's most effective and highest level of functioning is associated with the satisfaction of all three needs. Conversely, negative psychological consequences result when the three needs are not satisfied. These needs are universal and factors such as culture or location do not change the requirement that they be satisfied (Deci & Ryan, 2008). On a related note, individuals will pursue goals and activities that allow these three needs to be satisfied, and will experience positive outcomes if they are successful.

Within the SDT framework, humans are considered active, constantly seeking new challenges and experiences, thus making it an organismic approach (Deci & Ryan, 1985a). SDT posits that it is innate to humans to desire participation in new activities, work at their fullest capacity, and be socially connected (Deci & Ryan, 2000), thus mastering external forces such as environment, drives, and emotions (Deci & Ryan, 1985a).

SDT is differentiated, in that it investigates the kind of motivation that is happening at a given time, and can thus identify varying types of motivation (Deci & Ryan, 2008; Ryan & Deci, 2000b). The theory can make predictions for content and processes based on the content of an individual's goals and the regulatory processes through which the goals are pursued (Deci & Ryan, 2000).

Deci and Ryan (1985a) indicate that humans have a *need* to be self-determined, and that need can either be supported or hindered by environmental forces. Choice is a key facet of SDT, in that self-determined individuals act out of choice as opposed to out of obligation or coercion, and the choices are based on a combination of the individual's awareness of their needs and an interpretation of external events.

Types of Motivation

In SDT, the differentiation between different types of motivation is based on the reasons that give rise to an action (Deci & Ryan, 1985a; Ryan & Deci, 2000a). There are three types of motivation according to SDT: extrinsic, intrinsic, and amotivation.

Extrinsic motivation refers to an individual's completion of an activity for the sole purpose of receiving a reinforcing, separate consequence. Some perspectives find extrinsic motivation to lack autonomy, however, SDT posits that varying types of extrinsic motivation have varying levels of autonomy. Within SDT, degrees of autonomy differ; whether an activity is performed out of mere compliance or out of a personal, invested commitment to a separate result, the behavior is still extrinsically motivated (Ryan & Deci, 2000a, 2000b). These varying degrees of autonomy and external regulation within the construct of extrinsic motivation will be discussed later in this paper.

In contrast to extrinsic motivation is the idea of *intrinsic motivation*, or performing an activity because it is inherently enjoyable. This type of motivation is the innate human tendency to seek out challenges, to explore, and to exercise individual capacities (Deci & Ryan, 1985a; Ryan & Deci, 2000a, 2000b). Considering the two aspects of motivation discussed earlier, energization and direction of behavior, intrinsic motivation is the energizer of behavior, and it comes from an individual's central energy source (Deci & Ryan, 1985a). When an individual is intrinsically motivated to perform an activity, he or she will be interested in it, will enjoy it, will feel competent, and will often experience what is often called "flow." The individual performs the activity without a control or reward contingency, and it is typically accompanied by creativity and/or spontaneity (Deci & Ryan, 1985a; Deci & Ryan, 2000).

Amotivation is defined as the "state of lacking the intention to act" (Ryan & Deci, 2000b). It also has been referred to as personal helplessness, as behaviors that are amotivated are beyond the individual's intentional control (Abramson, Seligman, & Teasdale, 1978; Deci & Ryan, 1985a).

Mini-theories of SDT

There are four mini-theories which make up self-determination theory: cognitive evaluation theory, organismic integration theory, causality orientations theory, and basic needs theory. Basic needs theory was previously discussed, and cognitive evaluation theory, organismic integration theory, and causality orientations theory will be discussed in detail in the following section.

Cognitive evaluation theory (CET). The first sub-theory of SDT is cognitive evaluation theory (CET). In general, this sub-theory explains that intrinsic motivation occurs when an individual is participating in circumstances which are conducive to intrinsic motivation (Deci & Ryan, 1985a; Deci & Ryan, 2000). It was developed after the development of SDT in general in order to explain why different people have varying levels and types of intrinsic motivation (Ryan & Deci, 2000b). CET, therefore, analyzes the conditions and events that facilitate intrinsic motivation.

According to Deci and Ryan (1985a), the effect that an event has on an individual's motivation is determined by the event's psychological meaning for that individual. Events that play a role can be external, intrapersonal, or interpersonal, and individual differences should be taken into account in determining its effects.

CET focuses on two fundamental needs – competence and autonomy – yet more recent works also focus on relatedness as part of CET as it pertains to intrinsic motivation (Ryan & Deci, 2000b). According to the theory, events that catalyze feelings of competence can, in turn, catalyze intrinsic motivation, because the basic need for competence is satisfied (Deci & Ryan, 2000; Ryan & Deci, 2000a). However, feelings of competence will not enhance intrinsic motivation unless the individual also has a sense of autonomy, examples of which may be "optimal challenges, effectance-promoting feedback, and freedom from demeaning evaluations" (Ryan & Deci, 2000b, p. 70). On the other hand, an individual who does not feel autonomy, and experiences threats, deadlines, and negative performance feedback, will have less intrinsic motivation (Ryan & Deci, 2000b). In order to have high levels of intrinsic motivation, needs for both competence and autonomy must be satisfied; however, intrinsic motivation is only present during activities that have intrinsic interest for that individual.

The third fundamental need, relatedness, is not referenced in the literature as frequently as are the needs of competence and autonomy. Relatedness can be defined as “a sense of belongingness and connectedness to the persons, group, or culture disseminating a goal” (Ryan & Deci, 2000a, p. 64). However, it still plays a critical role in intrinsic motivation (Deci & Ryan, 2000; Ryan & Deci, 2000b). The need for relatedness seems to be the most applicable in studies of children and younger students (e.g., Anderson, Manoogian, & Reznick, 1976; Ryan & Grolnick, 1986).

Organismic integration theory (OIT). A second subtheory of SDT is organismic integration theory (OIT), which answers the question of how individuals value and self-regulate behaviors that are not intrinsically interesting. Deci and Ryan (1985a) explain that this theory can explain the development of both extrinsic and intrinsic motivation. OIT describes the various forms of external motivation and how each form can facilitate or hinder the internalization and integration of motivation (Ryan & Deci, 2000b). It explains how, in the development of intrinsic motivation, an individual’s curiosity becomes channeled while our innate tendencies and capacities interact with the environment (Deci & Ryan, 1985a). The theory further explains that when we internalize and thus integrate extrinsic regulations, it results in self-determined behavior and functioning. OIT continues to recognize the needs for competence and self-determination, and views them as motivational in the process of elaborating the internal structure of self while integrating both internal and external stimuli (p. 9).

The different types of external motivation are best described within the context of what is referred to in the literature as a self-determination continuum (Ryan & Deci, 2000b). The continuum describes behaviors ranging from amotivated to intrinsically motivated in terms of the degree to which the behaviors are self-determined (See Figure 1 below).

Before a discussion of the continuum, it is important to be familiar with the definition of internalization, as it is often referred to within the discussion. Generally speaking, internalization occurs when individuals turn socially- or culturally-imposed norms into their own personally endorsed values. In other words, external regulations are assimilated, so that, even though externally regulated, the individually is able to be self-determined (Deci & Ryan, 2000). Deci and Ryan (1985a) define assimilation as “the process through which the organism incorporates aspects of the environment into its preexisting cognitive structures (p. 117).

At the far left of the self-determination continuum is *amotivation.* When an individual is amotivated, there is no intention to act and no sense of personal causation (Ryan & Deci, 2000a).

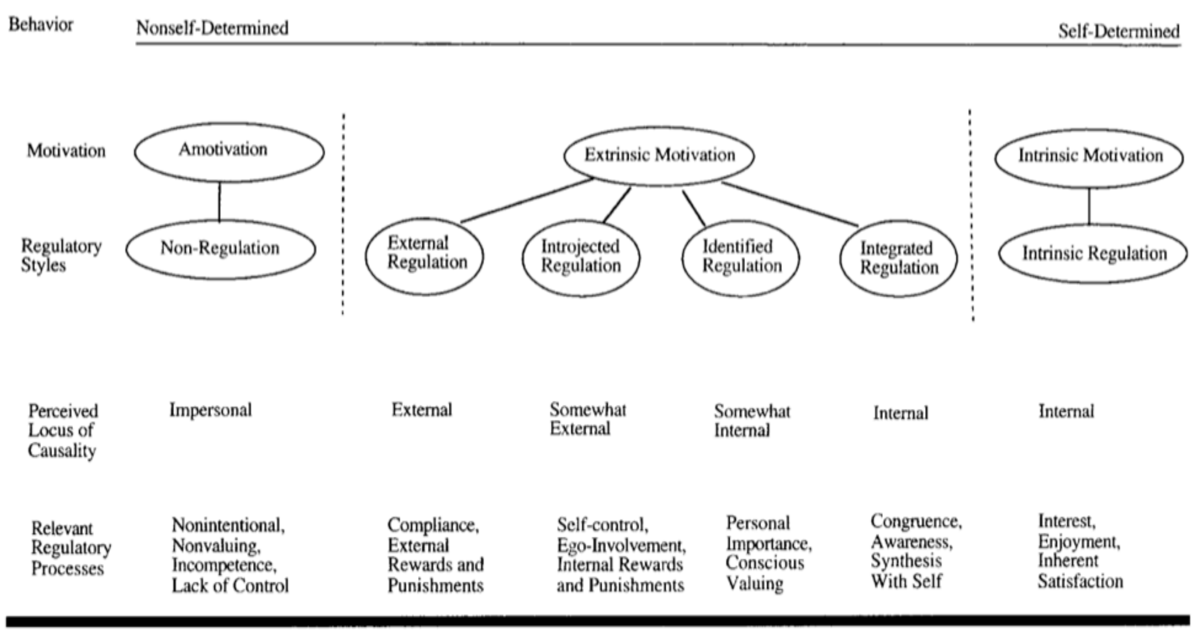

Figure 1. The self-determination continuum showing types of motivation with their regulatory styles, loci of causality, and corresponding processes. Reprinted from “Self-determination theory and the facilitation of intrinsic motivation, social development, and well-being,” by R.M. Ryan and E.L. Deci, 2000, *American Psychology, 55*(1), p. 72.

Ryan and Deci (2000b) indicate that amotivated people “just go through the motions” (p. 72).

The large section in the middle of the continuum contains the four forms of external motivation, which range from the least autonomous to the most autonomous, and therefore the least amount of internalization to the most amount of internalization (Deci & Ryan 2000; Ryan & Deci 2000a, 2000b). The four types of extrinsic motivation are external regulation, introjection (or introjected regulation), identified (or identified regulation), and integration. Each of these will be discussed in detail in the following paragraphs.

When an individual is externally regulated (*external regulation*), her behaviors are maintained only by external supports, and controlled only by specific external events. Behavior is performed in order to satisfy an external demand, which is often a demand from another individual (Deci & Ryan, 1985a; Deci & Ryan, 2000; Ryan & Deci, 2000a, 2000b). The perceived locus of causality is external (deCharms, 1968).

The second type of extrinsic motivation is *introjection*, or introjected regulation. While contingencies become internal instead of external, these contingencies are instead administered by the individual to himself (Deci & Ryan, 1985a; Deci & Ryan, 2000). Typically, the individual takes in a regulation but does not fully accept it as his own, often resulting in feelings of guilt, pressure, or anxiety. For example, when an individual is motivated to show that he is able to do something for the sole purpose of maintaining his own feelings of worth, that individual is experiencing introjection (Ryan & Deci, 2000a). The perceived locus of causality is still external, but is less external than it is in external regulation.

Identification, or identified regulation, is the third type of extrinsic motivation. At this point, the individual accepts the underlying value of the behavior as his own and begins to see the behavior as important. However, he has not yet assimilated the behavior. The locus of causality is somewhat internal, and the individual is probably performing the behavior more effectively.

The final type of extrinsic motivation on the self-determination continuum, and the most complete form of internalization of extrinsic motivation, is *integration*. While the individual is still not intrinsically motivated, he sees the importance of the behavior and assimilates it with other aspects of self, resulting in self-determined extrinsic motivation. The regulation comes into alignment with values and needs. It is important to keep in mind that while the behavior is assimilated, it is still not performed for inherent enjoyment.

At the far right of the self-determination continuum is *intrinsic motivation* which, as previously discussed, is performing an activity for the inherent purpose of doing the activity. Individuals who are intrinsically motivated to complete an activity are acting for their own enjoyment and satisfaction, and the perceived locus of causality is internal (deCharms, 1968).

Causality orientations theory (COT). The third subtheory of SDT is the causality orientations theory (COT). This can be defined as "a description of individual differences in the initiation and regulation of behavior" (Deci & Ryan, 1985a, p. 10). The theory is based on the premise that some individuals tend to be more autonomy-, control-, or impersonally-oriented than others, and these tendencies can predict individual constructs, attitudes, and behaviors. Further, the tendencies play a role in where the individual falls on the self-determination continuum (Deci & Ryan, 2000).

The three types of causality orientations are autonomy orientation, control orientation, and impersonal orientation (Deci & Ryan, 1985a). Deci and Ryan (1985a) articulate that each individual has some degree of each type of orientation, and that we can measure the strength of each orientation in order to predict psychological and behavioral variables.

An individual who is autonomously-oriented tends to initiate behavior towards events that are internal to his sense of self (Deci & Ryan, 1985a). Choice is a key factor in an autonomous orientation. These individuals use information to make choices and then self-regulate towards their own goals (p. 154). This may be manifested as, for example, a search for a job that would allow the individual to have a certain level of autonomy. This orientation is correlated most often with indicators of well-being such as self-actualization, self-esteem, and ego development (Deci & Ryan, 2000).

If an individual is oriented towards control, then his behavior tends to be initiated by events that are external to his own sense of self (Deci & Ryan, 1985a). This typically is associated with a power struggle between the controller and the controlled, and is associated with a high level of competence (however, it should be noted that this is not self-determined competence). It tends to be related to self-consciousness, pressure, and outward focus (Deci & Ryan, 2000).

An individual with an impersonal orientation senses that he is incompetent to handle challenges (Deci & Ryan, 1985a). This individual typically sees behavior and outcomes as independent of one another, and, often is seen as amotivated.

Deci and Ryan (1985b) developed the Causality Orientations Scale, which determines the degree to which an individual is oriented towards each orientation. The purpose of the scale's creation was to use the results to predict behavior across domains (Deci & Ryan, 1985a). While there is no correlation between the autonomy and control subscales, there is a positive correlation between the control and impersonal subscales, and a negative correlation between the autonomy and impersonal scales.

SDT and Health, Fitness, and Physical Activity

As explained earlier in this chapter, adults with I/DD are far less active and tend to be more overweight or obese than the general population. A recent line of research has focused on *why* some individuals engage in regular exercise and physical activity while others tend to remain sedentary. SDT can explain these reasons, and motivation can and should be explored in order to determine why adults with I/DD are not as active and are more likely to be overweight and obese. SDT framework is useful in determining not only why people differ in their levels of motivation, but also how different types and levels of motivation can influence behavior (Deci & Ryan, 1985). Standage and Ryan (2012) stated that any theory used in exercise science should address aspects of physical activity that are not intrinsically motivated, which SDT clearly does. Further, SDT can facilitate understanding of both initiation and persistence as they pertain to exercise behavior (Wilson, Mack, & Grattan, 2008).

In order for individuals with and without I/DD to increase activity level and change behavior, they must be motivated to do so. SDT details the nature and function of motivation, as well as potential conditions when motivation can be developed (Wilson et al., 2008). It provides a flexible framework in which we can understand patterns of exercise behavior, positive outcomes that results from exercise and physical activity, and the effects of different types and levels of motivation (Teixeira, Carraca, Markland, Silva, & Ryan, 2012).

Ryan and colleagues (2009) detailed a list of principles that have been considered for the use of SDT in the promotion of exercise and physical activity. The first of these is that engaging in physical activity may be intrinsically or extrinsically motivated, but that if it is intrinsically motivated, the individual is likely to maintain the activity for longer periods of time. Intrinsic motivation for exercise happens when the needs for autonomy and competence are supported. As stated previously, SDT posits that when an individual's needs for autonomy, competence, and relatedness are satisfied, that individual is able to act with autonomous motivation and function at his highest level (Deci & Ryan, 2000, 2002). SDT's explanation of the satisfaction of basic psychological needs as a necessity for autonomous forms of motivation is also valuable when considering exercise and physical activity. In exercise and physical activity, programs and interventions can be developed to ensure that the individuals' basic needs are being met (Van den Berghe, Vansteenkiste, Cardon, Kirk, & Haerens, 2014).

Another principle that Ryan et al. (2009) described was that if exercise or physical activity is extrinsically motivated, the individual's motives may vary in level of autonomy. The more autonomous the motives, the more positive the exercise experience, and the more that it is likely to be maintained. The differentiation of extrinsic motivation is useful in explaining why some individuals seem to strongly desire to participate in exercise while others avoid it (Teixeira et al., 2012).

Ryan and colleagues (2009) also emphasized the importance of the satisfaction of the needs for autonomy, competence, and relatedness. While most individuals are not intrinsically motivated to exercise, an individual will internalize and integrate extrinsic motivation for exercise when all of the needs are met. This fits into the self-determination continuum discussed earlier: an individual may not be intrinsically motivated to exercise, however, may learn and understand the importance of the behavior and assimilate it, thus resulting in self-determined extrinsic motivation (autonomous motivation). Friederichs et al. (2015) found that individuals with autonomous motivation had a more active lifestyle and higher scores on physical activity-related psychological measures than individuals with controlled or low motivation. Autonomously motivated individuals also demonstrated higher intention and commitment towards physical activity. Hawkins, Kalin, and Waldron (2014) noted that among college students, those who reported higher levels of basic needs satisfaction also reported higher levels of intrinsic motivation, identified regulation, and levels of physical activity.

SDT in the Literature

A number of studies have been conducted in which the feasibility of using the SDT framework within exercise and physical activity education, interventions, and programs has been demonstrated. There is a growing body of research on SDT within physical education settings in school.

The satisfaction of the basic psychological needs of autonomy, competence and relatedness seems to be the most frequently discussed aspect of SDT within physical education (PE) and the promotion of physical activity. Ntoumanis (2001) explained that of these three needs, perceived competence has the highest effect on participation in physical activity. This study found that students with higher levels of competence were more likely to enjoy PE, want to participate, and have self-determined motivation. George and colleagues (2013) also saw competence as important, as their study determined that the need for competence provided a stronger link to the perception of self-determination than did the needs of autonomy or relatedness.

In a similar finding, Standage, Duda, and Ntoumanis (2005) determined that the degree to which students in the sample found the PE setting to support their basic needs could predict their overall need satisfaction. More telling was the fact that need satisfaction predicted students' levels of intrinsic motivation and negatively predicted levels of amotivation (which, in turn, predicted student unhappiness). Schneider and Kwan (2013) concluded that in adolescents, intrinsic motivation to exercise is a combination of both satisfaction of basic psychological needs and the individual's positive affective response to the exercise, meaning that individuals may have greater motivation during enjoyable activities that support competence, relatedness, and autonomy. Social support also has been seen as important to the satisfaction of basic needs, as individuals who perceive they are socially supported generally show a positive relation to the three basic needs (George et al., 2013).

In recent studies, the basic need of relatedness is not always seen to be as predictive of autonomous motivation towards physical activity. Standage, Gillison, Ntoumanis, and Treasure (2012) found that relatedness was a positive, but not statistically significant, predictor, but that autonomy and competence were positive predictors and had positive effects on autonomous motivation towards exercise. Standage and Gillison (2007) also did not see relatedness as a significant predictor of autonomous motivation. A previous study by Standage et al. (2003), however, saw relatedness and competence to be more predictive of self-determined exercise behavior than autonomy in the physical education setting. The authors also expressed that the social context should still be autonomy-supportive. Wilson and Rogers (2008) also examined basic psychological needs, and found that competence was the dominant predictor of positive exercise-related behavior and physical activity. However, the authors discussed autonomy and relatedness as important to the internalization of extrinsically motivated exercise behaviors.

In addition to agreeing that need satisfaction is associated with greater self-determined motivation, Edmunds, Ntoumanis, and Duda (2006) also differentiated based on the types of extrinsic motivation. They examined the differentiated types of extrinsic motivation as they pertain to strenuous exercise behavior, and found that identified regulation significantly predicted it, introjected regulation positively predicted it, and external regulation negatively predicted it. This is aligned with the OIT sub-theory of SDT in that the more that the individual is able to internalize the regulation (the further right on the self-determination continuum and the closer to being intrinsically motivated), the harder the individual will work (the more strenuous exercise behavior he will engage in). Markland (1999) concluded that perceived competence is not a need that must be met if the individual inherently enjoys the activity and is therefore intrinsically motivated.

Other studies found the importance of perceived autonomy-supportive teachers and caregivers to be a key factor in levels of autonomous motivation (e.g., Lim & Wang, 2009; Standage & Gillison, 2007; Gillison, Standage, & Skevington, 2013). Further, Standage and Gillison (2007) considered a number of positive benefits that students have from interactions with autonomy-supportive teachers. Lonsdale et al. (2013) outlined the importance of promoting choice when measuring increases in physical activity and decreases in sedentary behavior. They found that student autonomy increased during activities involving free choice.

Most of the current literature on the use of SDT within physical education, physical activity promotion, and exercise intervention, pertains to school-aged children and adolescents without disabilities (Van den Berghe et al., 2014). Silva and colleagues (2010) investigated choice as an aspect of exercise in overweight adults. If adults believe that they have choice over the type of physical activities in which they participate, and also believe that they are able to perform the activity, they are more likely to develop self-determined motivation towards exercise.

When self-determination is discussed as it pertains to individuals with I/DD, it is typically not discussed as a reference to motivation, but as a set of functional skills that promote and enable independence. Wehmeyer (1999) detailed a functional model of self-determination, where individuals with I/DD have (or work towards having) a skill set that includes choice-making skills, problem-solving skills, goal setting and attainment skills, and self-awareness, among other elements. There is often a discussion on how to teach these skills so that individuals with I/DD can become "self-determined," however, health, fitness, and physical activity is typically left out of this discussion.

The literature pertaining to SDT as it pertains to exercise, physical activity, and physical education for individuals with I/DD is scarce, however, the theory is starting to receive more support as a valid theory of exercise behavior (Biddle & Nigg, 2000). In one article, the authors discussed the appropriateness of the use of SDT when evaluating individual athletes' motivation to participate in Special Olympics (Pozeriene, Adomaitiene, Osaseviciene, Reklaitiene, & Kragniene, 2008). Ntoumanis and Standage (2009) explained that the satisfaction of all three basic needs plays a key role in sportspersonship, and Joesaar, Hein, and Hagger (2012) found that athletes who perceived greater autonomy support from a coach demonstrated higher stability and intrinsic motivation.

More recently, Hamm and Driver (2015) discussed need satisfaction of individuals with Asperger syndrome as related to exercise, and then addressed strategies that could and should be implemented to enhance and increase satisfaction of each of the three needs. In order to address relatedness, the authors suggested that practitioners create an environment where relationships can be built and supported – a noncompetitive environment where individuals with communication deficits due to Asperger syndrome can maintain effective communication. These authors also suggested that the perceived competence of individuals with Asperger syndrome may be low because they typically have lower levels of strength and coordination than do their peers. This can be targeted by teaching the individuals to set goals and break down complex movements into simpler ones. Finally, to enhance autonomy in individuals with Asperger syndrome as it pertains to exercise, practitioners can educate the individuals on their choices and teach them to become self-advocates.

There is some literature pertaining to SDT and promotion of physical activity in individuals with various psychiatric disorders. Vancampfort and colleagues (2013, 2015) discussed SDT as it pertains to individuals with schizophrenia and affective disorders. A study by Vancampfort et al. (2015) determined that among individuals with affective disorders (major depressive disorder or bipolar disorder were included), those with higher levels of autonomous motivation were more physically active. The authors discussed ways to support individuals from this population, including providing choices, avoiding the use of external rewards, and providing opportunities for them to experience success. In another study, Vancampfort et al. (2013) found that among patients with schizophrenia, those with higher levels of self-determined motivation also demonstrated higher levels of physical activity. For this reason, the authors made similar suggestions as did Vancampfort et al. (2015), finding that practitioners can offer clear choice, avoid external rewards, and provide opportunities for patients to experience success.

Teaching Health, Fitness, and Physical Activity to Adults with I/DD

Fitness can be defined as a "set of attributes that people have or achieve that relates to the ability to perform physical activity" (U.S. Department of Health & Human Services, 1996, p. 21). It can also be thought of as a state of general well being when the individual is at low risk for health problems and has the energy and vitality to participate in a wide variety of physical activities (The President's Council on Physical Fitness & Sports, 2000). An individual who possesses this set of attributes is typically able to perform daily tasks well and has enough energy to enjoy leisure activities (U.S. Department of Health & Human Services, 1996).

While the terms exercise and physical fitness are often used interchangeably, the American College of Sports Medicine (ACSM, 2014) distinguishes the two terms. Exercise is a type of physical activity that consists of bodily movement to improve physical fitness, while physical fitness is the set of attributes relating to an individual's ability to engage in physical activity (ACSM, 2014; Caspersen, Powell, & Christenson, 1985).

A related, although different, concept is the idea of health. The Surgeon General's Report from 1996 described health as having physical, social, and psychological components (citing the 1988 International Consensus Conference on Physical Activity, Physical Fitness, and Health, Bouchard et al., 1990). When this condition is positive for an individual, it is associated with an individual's ability to enjoy life and handle challenges. On the other hand, when it is negative, it is associated with sickness and even premature death.

Fitness and Leisure

Physical activity can be categorized in many ways, but the most common way to categorize it is based on the portion of daily life during which the activity occurs (Caspersen et al., 1985). This usually means identifying whether the activity occurs while sleeping, at work, or at leisure. Leisure activities can be categorized even further, into classes such as sports, exercises, household activities, and other activities.

Talbott, Metter, and Fleg (2000) examined leisure-time physical activities of healthy adults and found that leisure-time physical activity is a contributor to overall cardiorespiratory fitness. Further, the researchers concluded that aging is associated with a decrease in leisure-time physical activity and that there is also usually a shift from high-intensity to low- and moderate-intensity physical activity as individuals age.

Fitness for Adults with I/DD

Adults with I/DD are more likely to be overweight or obese and less likely to engage in regular physical activity than are adults in the general population (e.g., Hsieh et al., 2014; Bodde et al., 2013; Rimmer & Yamaki, 2006; Barnes et al., 2013; Blick, et al., 2015; Bodde, Seo, Frey, Van Puymbroeck, & Lohrmann, 2012b; Borremans et al., 2010; Finlayson et al., 2011; Peterson et al., 2008; Stanish & Draheim, 2005). Research has shown this population is significantly more likely to have a sedentary lifestyle than is the general population (Havercamp et al., 2004).

Measurements of fitness for adults with I/DD. Tests of physical fitness can be generally categorized in two ways: health-related and physical fitness-related. Health-related tests include blood pressure and lipids/lipoproteins, among others (ACSM, 2014). Fitness-related measurements include body composition, body mass index (BMI), tests of cardiorespiratory fitness, muscular strength, endurance, and power, and flexibility (ACSM, 2014; U.S. Department of Health and Human Services, 1996). Physical activity levels are more difficult to measure. Accelerometers and pedometers have recently been used more frequently, as they can measure movement without having to rely on participant report.

Fitness testing for individuals with I/DD has been conducted in much the same manner as it has for individuals without I/DD. The fitness test depends on what the specific intervention is measuring, and many studies measure both health and fitness-related components. Calders et al. (2011) combined health and body composition measures (BMI and blood pressure) with cardiorespiratory fitness testing, a 6-minute walk test, muscular strength tests, and muscular endurance tests and found that combined cardiovascular and strength training was effective in this population. Pett et al. (2013) measured a variety of factors - weight, BMI, hip circumference, blood pressure, blood glucose, 6-minute walk test, and one rep max on leg press – to find overall reductions in weight and blood pressure and improvements in fitness measures. Hilgenkamp and colleagues (2012) measured cardiorespiratory endurance, muscular strength and endurance, and walking speed in order to determine the physical fitness levels of adults with I/DD. Due to the trend towards obesity in people with I/DD, measurements such as weight, BMI, and circumferences are often used to measure health-related fitness in this population (e.g., Bazzano et al., 2009; Calders et al., 2011; Pett et al., 2013; Rimmer, Heller, Wang, & Valerio, 2004)

Accelerometers and pedometers have often been used to measure physical activity, as they are an objective way to measure levels of physical activity without having to rely on self-report (Barnes et al., 2013; Bodde et al., 2013). Data from wearing an accelerometer for seven days is a common measure of physical activity levels for individuals with I/DD (Bodde et al., 2013; Frey, Buchanan, & Sandt, 2005; Phillips & Holland, 2011; Temple, Anderson, & Walkley, 2000; Temple & Walkley, 2003). Pedometers have been used to measure activity in this population (Stanish, 2004; Stanish & Draheim, 2005; Stanish & Draheim, 2007).

Subjective measures have often been used in studies of physical activity level for individuals with I/DD. Self-report and questionnaires have been used more often than have other subjective methods (Barnes et al., 2013; Temple, Frey, & Stanish, 2006). Barnes et al. (2013) indicated that a combination of objective and subjective measures is the most effective way to measure levels of physical activity in this population. However, they noted that only a few studies for individuals with I/DD used multiple measures; most use one measure or another. This study measured BMI as well as levels of physical activity, both via accelerometer result and self-report, to find connections between obesity and activity levels.

Barriers to Improving Health, Fitness, and Physical Activity in Adults with I/DD

There is clearly a need for individuals with I/DD to improve physical fitness and levels of physical activity so that they can live healthier lifestyles and experience both physical and psychosocial benefits (Heller, Hsieh, & Rimmer, 2004). Physical activity can not only help adults with I/DD to make positive physical changes, such as greater aerobic fitness, muscular strength and endurance, improvements in mobility, and reduction of cardiovascular risk factors (Calders et al., 2011; Stanish & Frey, 2008), but also can help this population develop more positive attitudes towards exercise and therefore improvement in psychosocial outcomes (Heller et al., 2004).

However, a number of barriers exist that often make such improvements difficult. These barriers will be discussed in detail in the following section, but the overarching theme is that because people with I/DD have less control over their own environment than do people without I/DD, they have fewer opportunities to be active and to participate in health- and fitness-promoting activities.

One of the most-often cited barriers in the current literature is related to limited financial resources (Heller, Hsieh, & Rimmer, 2002; Heller et al., 2004; Frey et al., 2005; Messent, Cooke, & Long, 1999; Rimmer, 1999). Adults with I/DD may not have high-paying jobs or may use government assistance as their primary income, so costs for activities such as gym memberships, transportation costs, facility fees, and staffing fees may be too high.

Another potential barrier to which the research often refers is staffing issues in general. Whether the health- and fitness-promoting activities occur in a fitness center, rehabilitation facility, day center, or residential center, it is crucial that the staff are trained in best practices on how to promote physical activity in adults with I/DD. Researchers of several studies discussed the lack of trained personnel working with this population, including healthcare staff and fitness facility staff (e.g., Doody & Doody, 2012; Heller et al., 2004; Lotan, Henderson, & Merrick, 2006; Stanish & Frey, 2008). Another significant issue related to staffing is ratio, as ratios in many facilities may not be low enough to sufficiently support individuals with I/DD so that they can fully participate (Messent et al., 1999).

A related issue is that of policy. Researchers have indicated that unclear policies on how to promote physical activity in adults with I/DD and how to provide these services can be a sizeable barrier to participation in physical activity (Messent et al., 1999; Temple & Walkley, 2007).

A third often-discussed barrier in this area is that of transportation. Because a number of adults with I/DD do not drive and must rely on others (family, caretakers, public transportation) to get around, obtaining access to fitness facilities is a barrier to participation in physical activity (Frey et al., 2005, Heller et al., 2002).

Bartlo and Klein (2011) indicated that one very important barrier is that there are limited activity programs that are available for this population. If they are available, however, they are often not easily accessible or modifiable to individuals with I/DD. Messent et al. (1999) agreed, suggesting that there are generally limited leisure options for this population within the community.

Other identified potential cognitive-emotional barriers include lack of energy, perceived difficulty, health concerns, and lack of motivation (Heller et al., 2002; Heller et al., 2004), as well as not having someone to exercise with (Heller et al., 2002).

Solutions to Alleviate Barriers

In order to describe what are currently considered to be "best practices" to improve the health, fitness, and physical activity of adults with I/DD, it is important to address solutions to the barriers defined above. It should be noted that there is not a great deal of research concerning the health behaviors of individuals with I/DD, the barriers and supports to participation in physical activity, or the best practices in this area in general (e.g., Rimmer, 1999; Spanos, Melville, & Hankey, 2013; Stanish & Frey, 2008; Temple et al., 2006). This section of this chapter will identify and briefly describe potential solutions to the barriers already described. It will identify greater themes within the research and identify more general "best practices" based on these themes.

There are several ways that the barrier of limited financial resources can be addressed. First, and most obvious, is to make physical activity interventions free or low cost to people with I/DD. This can be accomplished in a number of ways, including subsidized or lower fees for fitness center memberships and availability of activities at home or at work (Heller et al., 2002; Stanish & Frey, 2008). Making physical activity available at the individual's home or work would also address the barrier of transportation, as would transporting the individuals to the fitness center. Stanish and Frey (2008) suggested that an easy, low-cost physical activity could be to increase walking speed during regular daily activity and then reduce the amount of sedentary time that takes place during the regular daily routine.

Stanish and Frey (2008) also recommended that caregivers and families of individuals with I/DD be included as part of the fitness activity or intervention. Programs must ensure that they have the "knowledge, skills, and resources to facilitate healthy living" for the individual with I/DD so that they can play a positive and supporting role (p. 182).

The solution to potential barriers that has been the most discussed in the literature is the need for trained professionals who can help facilitate and maintain physical activity within individuals with I/DD (Frey et al., 2005). Rimmer (1999) saw an "urgent need for fitness professionals to become more knowledgeable about disability" (p. 496). Fitness professionals should be trained on how to provide modifications during activities for individuals with I/DD, how to promote inclusion with individuals without I/DD during activities, and how to promote communication (Marks, Sisirak, & Chang, 2013; Rimmer, 1999; Stanish & Frey 2008).

The first "best practice" that has been identified in the literature is that programs whose aim is to promote health, fitness, and physical activity in individuals with I/DD should be tied into larger health promotion and education efforts, including nutrition and other health behaviors (Abdullah et al., 2004; Bazzano et al., 2009; Havercamp et al., 2004; Marks et al., 2013; Stanish & Frey 2008). Simply put, multi-component interventions and programs seem to be effective for this population in promoting healthy behaviors and physical activity. One example is the Healthy Lifestyle Change Program (Bazzano et al., 2009). A 7-month, twice-weekly program, it successfully incorporated health education, exercise, and nutrition education, as most (60%) of its participants increased physical activity levels and improved eating habits and two-thirds either lost or maintained weight. A second, similar program, HealthMatters: Train-the-trainer Model, was developed to promote healthy behaviors in adults with I/DD (Marks et al., 2013). This intervention also included substantial training for the fitness and healthcare staff at the facility (therefore addressing the barrier of a lack of trained professionals to work with this population). The intervention combined nutrition and health education with physical activity. Participants significantly improved in all areas, including general health knowledge and physical fitness. A third example of such a program was the Healthy Lifestyles Program (Abdullah et al., 2004). It encompassed and promoted a variety of aspects of health, including emotional health, physical health, health through meaningful activities, and social health, and also reviewed self-care and connecting with others. Early and sustained improvements in health behaviors were noted.

Bodde et al. (2012b) explained that there are very few health promotion programs that include teaching individuals with I/DD about physical activity. In another study, Bodde et al. (2013) explained that programs should incorporate health-related knowledge, skills, and information on opportunities for participation in physical activity, and Rimmer (1999) emphasized the importance of including a nutrition education aspect.

Another best practice that has been identified is that fitness intervention programs should include the same fitness components as for the general population - cardiovascular endurance, strength, flexibility, and, to a lesser extent, balance – and that fitness interventions should be delivered in combined types of fitness activities. Bartlo and Klein (2011) suggested that aerobic training is an integral part of any physical activity intervention. They went on to explain that while resistance training should be included as it is beneficial for individuals with and without disabilities, improvements in strengths are not necessarily a requirement in order to see improvement in daily functioning. Rimmer (1999) described the possibility that while all programs should include the standard cardiovascular, strength, and flexibility components, a program for people with I/DD may incorporate different types of fitness that are most accessible for that population. Bartlo and Klein (2011) described the importance of balance: because problems with balance are common in people with I/DD, programs should include balance intervention in order to prevent falls and other injuries. Oviedo, Guerra-Balic, Baynard, and Javierre (2014) agreed with the need for a balance component: these authors emphasized balance as being crucial to increase and then maintain activities of daily living, prevent risks of falls and injuries, and to prevent a decline in functioning. The intervention in this study proved to be successful, as participants decreased body weight and body mass index (BMI), and increased cardiovascular fitness, handgrip strength, leg strength, and balance. Calders et al. (2011) found significant positive effects on individuals' physical fitness levels after a combined exercise training program. Their study incorporated both strength and cardiovascular endurance exercises, and resulted in improvements in cholesterol levels, cardiovascular functioning, strength, and balance.

Recruiting both experts on disabilities (who do not have disabilities themselves) as well as individuals with I/DD to assist in the development of such a program has been identified as an effective practice (Abdullah et al., 2004; Bazzano et al., 2009; Bodde et al., 2012a). In the past, people with I/DD have been excluded from participating in their own health care, fitness, and self-management because others assumed that they were not able to due to their cognitive limitations (Bazzano et al., 2009). However, several studies actually included potential participants in the development of the interventions, and individuals with I/DD were able to assist in the design and implementation of the interventions. Stanish and Frey (2008) suggested that future programs ask people with I/DD to choose activities and make decisions, and Bartlo and Klein (2011) indicated that this participation is key, as it can lead to greater participation and adherence to the program.

Another best practice is to implement community-based activities and recruit peer mentors in order to promote inclusion with the general population (Bazzano et al., 2009; Lotan et al., 2006; Marks et al., 2013). Heller, McCubbin, Drum, and Peterson (2011) found evidence for both fitness and psychosocial benefits of community-based programs for individuals with I/DD. The HealthMatters: Train-the-Trainer program, discussed earlier, took place within community-based organizations, and participants saw significant improvements in social supports (Marks et al., 2013). The Healthy Lifestyle Change program (Bazzano et al., 2009) was also community-based, and based this on Rimmer's (1999) discussion that research has traditionally been performed "on" those with I/DD instead of "with" those with I/DD. Bazzano et al. (2009) suggested that part of the success of the program was due to the fact that it was community-based.

Stanish and Frey (2008) listed a number of strategies that can be implemented when developing health and fitness promotion and intervention programs for people with I/DD. For purposes of this review, these strategies can be considered best practices for such programs. These authors suggested that programs should include motivational strategies, incorporate low to moderate impact activities such as walking, provide fun activities that involve the use of social skills, allow participants to choose activities and make decisions, ensure that activities are age- and developmentally-appropriate, provide community-based activities for inclusion, ensure that providers know how to modify activities for varying abilities, and include goal setting.

Future Research

There is currently limited research concerning health, fitness, and physical activity for adults with I/DD (e.g., Rimmer, 1999; Spanos et al., 2013; Stanish & Frey, 2008; Temple et al., 2006). For this reason, the overarching theme in the current literature is a need for research that explores best practices in health and fitness promotion in this population. Phillips and Holland (2011) articulated the need for "well-designed, accessible, preventive health promotion strategies and interventions designed to raise the levels of physical activity for individuals with intellectual disability which take into account the unique barriers to physical activity this group faces" (p. 6). As far back as 1999, Rimmer indicated that further programming in this field must become a strong focus, and that work should be done towards the prevention of certain negative health conditions.

The most effective specific type of physical activity intervention is something that was identified as lacking in the literature. Oviedo et al. (2014) explained that intensity, frequency, and volume of activities should be investigated in order to determine what is most beneficial. A related suggestion for future research is to identify how current effective programs can be adapted for those of varying ability levels (Bartlo & Klein, 2011).

Bodde et al. (2013) identified a need to explore the relationship between health knowledge and physical activity in this population. By exploring this relationship, as well as the relationship between health knowledge and other variables such as BMI and gender, we will have more information that can inform health promotion interventions as well as facilitate an increase in physical activity. Other relationships that can be explored in future research include the relationship between activity and health-related factors (e.g., body composition and blood pressure, Stanish & Draheim, 2007) and age-associated health problems and I/DD (Bodde et al., 2012a, 2012b).

Bodde et al. (2012a) identified the importance of research that is driven by health behavior theories. By using theory to determine what facilitates and motivates healthy behaviors, more new, effective physical activity promotion programs can be formed. Further, strategies that positively influence level of participation and individual persistence can be investigated by researching what types of strategies work with this population (Bartlo & Klein, 2011).

Authors of several studies made recommendations for setting and participants in future studies. Bodde et al. (2013) suggested that more interventions should take place in workplace and residential settings. This would give the participants health-related knowledge and skills that pertain to their relevant settings, as well as the tools to participate more fully in physical activity in setting with which they are familiar. Bazzano et al. (2009) indicated a need for larger, randomized controlled studies of specified health promotion interventions. These authors also suggested that interventions should demonstrate long term outcomes. Temple, Frey, and Stanish (2006) articulated a need for research with more representative samples, including comparison groups, to determine whether health, fitness, and physical activity interventions are actually working.

Self-Management to Teach Health, Fitness, and Physical Activity to Adults with I/DD

Very broadly speaking, self-management is a way to change individual behavior in which an "individual controls the sources of variation in his or her own behavior" (Karoly, 1982, p. 27). It is part of the even broader idea of self-regulation, in which the greater goal is to allow individuals to manage, monitor, record, and assess their own behavior or skill performance (Reid, Trout, & Schartz, 2005; Slattery, Crosland, & Iovannone, 2015).

The literature is inconsistent in identifying interventions as self-management, self-monitoring, self-evaluation, or self-regulation, and the terms are often used interchangeably. For purposes of this chapter, we will consider self-regulation to be the broader idea, of which self-management is a method. Self-monitoring, self-evaluation, and self-reinforcement will be referred to as components of self-management.

Models and Components of Self-Management

In self-management interventions, self-regulation strategies are employed to assist an individual in developing more self-regulatory behavior. Browder and Shapiro (1985) defined self-management as everything that an individual does to influence his or her own behavior.

There are varying models of self-management or self-monitoring, two terms which are often used interchangeably (i.e., Kanfer, 1970; Nelson & Hayes, 1981; Rachlin, 1974). Kanfer's model (1970) typically is identified as a three-state (or three-component) model in which the three components or stages – self-monitoring, self-evaluation, and self-reinforcement – work together; more specifically, self-monitoring leads to self-evaluation, which then leads to self-reinforcement. When this happens, the frequency of responses is changed. Kanfer also suggested the idea of a "feedback loop" which consists of an individual's continuous monitoring, evaluation, and reinforcing of the target behavior (p. 151).

Self-monitoring. Self-monitoring happens when individuals, as opposed to their teachers or caretakers, observe and record their own behaviors (Fantuzzo, Polite, Cook, & Quinn, 1988; Mace, Belfiore, & Hutchinson, 2001). There are two steps involved: discriminating the occurrence of a target response and recording by the individual of that response (Mace et al., 2001; Reid et al., 2005). The recording happens when the individual compares the target behavior to an external standard at a given interval, and graphing of the target behavior is frequently implemented as a component.

Reinforcement often is included in a self-monitoring plan, and happens when a student is externally reinforced for a change in the target behavior. This may then lead to an increase in the salience of the self-monitoring (Reid et al., 2005).

Such interventions may promote generalization of newly acquired skills as well as maintenance of those skills (Harchik, Sherman, & Sheldon, 1992). Holman and Baer (1979) determined that generalization occurred from the training setting to the classroom setting "without elaborate reprogramming" (p. 442). They also found that students improved performance on the original skill after the self-management training.

Nelson and Hayes (1981) identified additional components of the self-monitoring stage of self-management interventions. Their work suggested that the individual's recording of the behavior does not only cause the change, but that environmental events can also cause changes in behavior. Additional possible components of the self-monitoring stage that were identified included goal setting, instruction and training, obtaining a self-monitoring device, others commenting on the self-monitoring device, observing, recording, self-evaluating, and self-consequences.

Self-evaluation. The self-evaluation component of self-management interventions consists of the student observing his own behavior or performance towards a task and determining whether he performed it correctly or met the behavior criterion (Johnson, Graham, & Harris, 1997). This stage includes setting standards to which the individual compares his or her own behavior (Kanfer, 1970). The individual assesses, matches, and then corrects his own behavior as a part of this stage, and then can determine if he has improved, remained the same, or worsened with each recording (Lovett & Haring, 1989).

Self-reinforcement. Self-reinforcement is considered a key component of self-management (Brigham, 1982). Mace and colleagues (2001) identified self-reinforcement as when an individual independently obtains a stimulus (reinforcer) after performing a behavior to satisfy a predetermined performance standard. Students award themselves positively if they independently determine that they have met the target behavior (Brigham, 1982). The ultimate goal of self-reinforcement is to encourage students to use the procedures that they have been taught to manage their own behavior and learning.

Other components. Fantuzzo, Rohrbeck, and Azar (1987) developed the Self-Management Intervention Checklist (SMIC). This consists of 11 basic intervention components, the definition of each, and the criteria. The components included in the SMIC are more detailed than are the more general components of self-monitoring, self-evaluation, and self-reinforcement, and not all of the components are required in order for an intervention to be considered a self-management intervention. Possible components include selection of target behavior, definition, selection of primary reinforcers, performance goal, instructional prompt, observation, recording, evaluation, administration of secondary reinforcers, administration of primary reinforcers, and monitoring (Fantuzzo et al., 1987).

Selection of target behaviors is one component that is typically required in a self-management intervention. These interventions can be applied to a variety of potential target behaviors, including specific academic skills, work habits, desirable or undesirable behaviors, and study skills (Skinner & Smith, 1992). The behavior should be overtly observable by others; otherwise, the integrity of the interventions cannot be evaluated. It should also be determined based on the student's current level of functioning and preference.

Goal setting, another secondary component that is implemented frequently in such interventions, should occur before the start of any intervention. Research has shown that students who set their own goals typically demonstrate greater performance than those who do not set their own goals (e.g., Johnson et al., 1997; Olympia, Sheridan, Jenson, & Andrews, 1994). The goal can be either behavior- or performance-based, and should be challenging yet achievable.

Using Self-Management to Teach Health, Fitness, and Physical Activity to Adults with I/DD

Self-management strategies are appropriate to use when teaching health, fitness, and physical activity to individuals with I/DD for two reasons. First, this type of intervention can facilitate an increase in physical activity levels and health behaviors. Second, the use of self-management strategies for these types of behaviors can contribute to a high overall quality of life. These two ideas will be discussed in turn in the following paragraphs.

Some studies have been conducted in which the use and effectiveness of self-management strategies have been examined in relation to health behaviors; however, there is not a great deal of research in this area (Dishman, 1991). Generally speaking, it has been found that interventions that include self-monitoring of physical activity levels and/or diet can improve health-related behaviors in the general population (Lombard, Lombard, & Winett, 1995; Weber & Wernheim, 1989). However, virtually all of the research in this area has been focused on individuals without disabilities.

Saelens et al. (2000) used a self-management intervention to promote physical activity and found that college-aged women who used the strategies had higher rates of physical activity than did those who did not use the strategies. These authors discussed the importance of identifying self-management strategies that work to increase physical activity levels because so little of the population actually meets recommended levels of physical activity. A similar study used self-monitoring interventions as a part of a behavioral weight loss program and found that physical activity levels and outcomes were improved (Carels et al., 2005).

As stated above, there is very limited research on the use of self-management strategies to promote health behaviors and physical activity in individuals with I/DD. However, as self-management has been an effective intervention for a variety of other behaviors, it seems logical to assume that it would be equally as effective in improving health, fitness, and physical activity for this population.

Self-management and quality of life. We can examine the relationship between self-regulated behavior, self-determined behavior, and overall positive quality of life to provide a rationale for why self-management strategies are appropriate in the area of health, fitness and physical activity. Further, the individual need for independence as a contributor to quality of life also can provide rationale for implementing self-management strategies.

Quality of life is a concept that is difficult to define, but can be considered an overall sense of well-being that includes physical, material, social, and emotional well-being, along with personal development and purposeful activity (Felce & Perry, 1995). Schalock (1996) identified eight core principles of quality of life: emotional well-being, interpersonal relations, material well-being, personal development, physical well-being, self-determination, social inclusion, and rights.

Self-determination, one of these key principles, contributes to a positive quality of life (Wehmeyer & Schwartz, 1998) and occurs when the individual's behavior is self-regulated (Wehmeyer, 1996). In fact, Turnbull and Turnbull (2001) found a relationship between self-regulated behavior, self-determined behavior, and overall quality of life. Self-regulated behavior occurs when the individual is able to make decisions about which skills to use in a situation and then determine a plan of action to take. By their very definition, self-management strategies allow individuals to control their own behavior, and therefore have self-regulated behavior. Self-management strategies may empower individuals with I/DD to manage their own behavior and therefore enhance self-determination and quality of life.

Independence also has been identified as a component of a high quality of life, and an important goal for individuals with disabilities (Carr, Moore, & Anderson, 2014). Individuals with greater independence and control tend to have a higher quality of life (Wehmeyer & Schwartz, 1998). Self-management strategies provide a mechanism by which individuals can increase their level of independence and decrease their need for supervision and prompting (Mechling, 2007).

Self-management strategies for people with I/DD. The application of self-management strategies has been successful in a variety of natural settings in helping individuals with I/DD to become more independent (Carr et al., 2014). These types of strategies can "increase students' self-reliance, facilitate skill generalization, and free teachers and staff from full management responsibility" (Lee, Simpson, & Shogren, 2007, p. 3). Additionally, they can positively affect an individual's independent functioning at both home and work (Harchik et al., 1992).

There is limited research on the use of self-management strategies to teach health and fitness or to increase physical activity levels of people with I/DD; virtually all of the research focuses on individuals without disabilities. Todd and Reid (2006) found that a physical activity intervention that included a self-monitoring piece improved physical activity levels in students with autism. Coleman and Whitman (1984) determined that individuals with I/DD are able to use self-monitoring and self-reinforcement in order to make improvements in exercise behavior.

Purpose

Research has demonstrated that higher levels of physical activity can decrease the likelihood of being overweight or obese as well as prevent other negative health outcomes (U.S. Department of Health and Human Services, 2008; CDC, 2014). Research also has shown that adults with I/DD are more likely to obese, less likely to be physically active, and at greater risk for cardiovascular disease and musculoskeletal health conditions than the general population (Hsieh et al., 2014; Barnes et al., 2013; Blick et al., 2015; Bodde et al., 2012b; Borremans et al., 2010; Finlayson et al., 2011; Havercamp et al., 2004; Hilgenkamp et al., 2012; Peterson et al., 2008; Stanish & Draheim, 2005). For these reasons, there is a need for interventions which aim to increase physical activity levels of adults with I/DD. There is also a need to determine which interventions are the most effective in increasing physical activity levels within this population. Self-management strategies are one way to encourage individuals to monitor their own physical activity levels, thus promoting independence and contributing to a higher overall quality of life. Such strategies can be incorporated into modern technology. Research is needed in order to determine (1) whether such interventions play a role in increasing physical activity levels, and (2) whether individuals with I/DD find value in such interventions.

Research Questions

Both studies implemented single subject designs in order to examine whether a functional relation existed between the use of self-management interventions (incorporating a physical activity monitor application and accessed through a wearable device) and levels of individual physical activity.

Study 1. The purpose of this study was to examine the effects of a goal-setting intervention using Fitbit devices on the physical activity level of college students with I/DD. Specific research questions included:

1. What are the effects of goal-setting sessions using Fitbit devices on the physical activity level of college students with I/DD?
2. Do college students with I/DD find value in incorporating goal-setting interventions into the use of a Fitbit device?

Study 2. The purpose of this study was to examine the effects of app-based social reinforcement on the physical activity levels of college students with I/DD. Specific research questions included:

1. What are the effects of app-based social reinforcement on the physical activity levels of college students with I/DD?
2. Do college students with I/DD find value in incorporating public encouragement challenges into the use of a Fitbit device?

Chapter 2

Experiment 1: Using a Goal-Setting Intervention to Increase Physical Activity of College Students with Intellectual and Developmental Disabilities

Adults with I/DD tend to fall behind the general population in all areas of fitness, health, and physical activity. A greater percentage of adults with I/DD are obese than are adults without: 38.3% compared to 28% (Hsieh et al., 2014). Morbid obesity is also more prevalent in adults with I/DD than it is in those without (7.4% vs. 4.2%), and women with I/DD and individuals with Down Syndrome are even more likely to be obese (Bodde et al., 2013; Hsieh et al., 2014; Rimmer & Yamaki, 2006).

It is well known that obesity can be prevented and healthy weight can be maintained through physical activity (CDC, 2014). National physical activity guidelines recommend that adults participate in regular physical activity, which means at least 150 minutes per week of moderate intensity activity or 75 minutes per week of vigorous intensity activity (U.S. Department of Health and Human Services, 2008). The guidelines indicate that physical activity can play a role in preventing a number of negative health outcomes, and the recommendations and benefits are the same for people with and without I/DD.

However, in individuals with I/DD, decreased physical activity and inactivity are far more common than in the general population (e.g., Barnes et al., 2013; Blick et al., 2015; Bodde et al., 2012b; Borremans et al., 2010; Finlayson et al., 2011; Havercamp et al., 2004; Peterson et al., 2008; Stanish & Draheim, 2005). This group is also at risk for cardiovascular disease and musculoskeletal health conditions (Hilgenkamp et al., 2012).

Measurement of Physical Activity and Fitness

Physical fitness in adults with I/DD has been measured in relatively the same manner that it is measured in the general population: health- and physical fitness-related testing, body composition, cardiorespiratory fitness levels, muscular strength, endurance, and power, flexibility, and physical activity levels (ACSM, 2014; U.S. Department of Health and Human Services, 2008).

Physical activity levels are often difficult to measure. Accelerometers and pedometers have recently been used more frequently, as they are an objective way to measure levels of physical activity without having to rely on self-reported information (Barnes et al., 2013; Bodde et al., 2013). Data from wearing an accelerometer for seven days is a common measure of physical activity levels for individuals with I/DD (Bodde et al., 2013; Frey et al., 2005; Phillips & Holland, 2011; Temple et al., 2000; Temple & Walkley, 2003). Pedometers have also been used to measure activity in this population (Stanish 2004; Stanish & Draheim, 2005; Stanish & Draheim, 2007).

Goal Setting to Increase Physical Activity

Self-management strategies are appropriate to use when teaching health, fitness, and physical activity to individuals with I/DD, as these types of interventions can facilitate an increase in physical activity levels and health behaviors. Goal setting is one component that is frequently included in self-management interventions. Research has shown that students who set their own goals typically demonstrate greater performance than those who do not set their own goals (e.g., Johnson et al., 1997; Olympia et al., 1994). The goal can be either behavior- or performance-based, and should be challenging yet achievable.

There has been some research on the use of self-management strategies, including goal setting, to improve exercise behavior and increase physical activity levels (e.g., Baghurst, Tapps, & Kensinger, 2015; Consolvo, Klasnja, McDonald, & Landay, 2004; Munson & Consolvo, 2012). However, virtually all of the research focuses on individuals without disabilities. Baghurst et al. (2015) found that goal-setting interventions to increase physical activity levels should incorporate three types of goals - outcome, performance, and process - for best results. Other studies found that participants preferred goals to start at the beginning of the week and reset at the end of the week, and that weekly goals and reminders are beneficial when aiming to increase physical activity levels (Consolvo et al., 2004; Munson & Consolvo 2012). The CDC (2011) identified a number of potential interventions to increase physical activity levels in the community, and included goal setting as one way to change health behavior on an individual level.

While most of the research focuses on individuals without disabilities, two studies in particular focused on individuals with disabilities, in particular, with developmental disabilities. Todd and Reid (2006) found that an intervention with a self-monitoring piece could improve physical activity levels in students with autism. This intervention included three parts -- a self-monitoring board, verbal encouragement, and edible reinforcement – with the goal of increasing physical activity in the form of walking and snowshoeing circuits. The participants, three males with autism between the ages of 15 and 20 years, recorded each time that they completed a circuit on their own tracking board. Results indicated that all participants increased the number of circuits that they were able to complete, and the authors discussed that the intervention led to more sustained participation in physical activity. The authors also discussed the likelihood of the self-monitoring piece contributing to an increase in internal motivation, as the edible reinforcers made no difference in physical activity when they were withdrawn at the end of the intervention.

Coleman and Whitman (1984) determined that individuals with I/DD were able to successfully implement self-monitoring strategies in order to make improvements in exercise behavior. The participants, adults with intellectual disabilities, participated in a physical fitness program with the goal to improve exercise behavior, fitness measurements, and fitness performance. Participants monitored their own exercise behaviors, recorded their measurements and performance, and rewarded themselves. The authors determined that participants demonstrated reliable positive changes in exercise behavior and that they were successfully able to self-monitor with accuracy.

Technology for Goal Setting and Physical Activity Levels

Traditionally, self-monitoring of physical activity levels has been performed with diaries on paper. Recently, various forms of technology have been introduced and used to serve the same purpose. Despite the amount of technology available, adherence to self-monitoring of physical activity at all is more important for lasting lifestyle changes than any specific self-monitoring method (Burke et al., 2012; Marshall, Leslie, Bauman, Marcus, & Owen, 2003). Self-monitoring interventions in this area need further evaluation and refinement before their full potential can be determined (Norman et al., 2007).

One of the most common forms of technology used to track physical activity is an accelerometer-based activity monitor. This type of device provides real-time estimates of different aspects of physical activity – frequency, duration, and intensity (Trost, McIver, & Pate, 2005). Accelerometers use a motion sensor to measure the acceleration of the trunk and limbs.

As acceleration is related proportionally to energy expenditure, an individual's movement, steps, and energy expenditure can be tracked.

More effective than traditional pedometers, which can only measure footfalls (walking or running), accelerometers can distinguish between walking and running, and are therefore more accurate in determining activity levels and energy expenditures (Physical Activity Resource Center for Public Health, 2015a,b). Accelerometers do have their limitations, however, in that they are unable to accurately measure steps during activities such as the bicycle, elliptical machine, or weight-bearing activities. Further, they cannot read movement of the upper extremities.

Accelerometers fit into the greater category of wearable devices, which only require that the individual wear the device – on the wrist, clipped on to an item of clothing, as an arm band, or in a pocket – and the device automatically tracks activity level via sensor (accelerometer or altimeter). While these devices are easy to use, they are often limited because they only track activity that can be sensed. For this reason, data from other sources should also be incorporated in order to obtain a complete picture of health and fitness levels. They all provide some kind of self-monitoring and visualization of activity level, and most also allow the participant to set goals related to behavior and activity level (Fritz, Huang, Murphy, & Zimmerman, 2014). Most wearable devices can also be considered "persuasive technology," as they self-monitor for the purpose of "persuading" the participant to engage in additional activity (Fritz et al., 2014). The devices use a variety of strategies to influence behavior and activities. Specific brand name examples of wearable, persuasive technology include UbiFit, Chick Clique, Nike+ Fuel Band, Jawbone UP, Striiv, and Bodybugg.

One popular brand of wearable device is the Fitbit, which uses a triaxial accelerometer to measure activity level, specifically, steps (Fitbit Help, 2015). Triaxial accelerometers measure acceleration in three planes: vertical, horizontal, and medial; uniaxial accelerometers measure acceleration in a single plane, usually vertical (Freedson & Miller, 2000). Fitbits have a corresponding app that is accessible via smartphone, tablet, or computer, where users can track their steps taken per day, active minutes, miles walked, calories burned, and sleep patterns. The device is worn on the wrist as a bracelet, and use of the app is simple and relatively intuitive. There are goal-setting capabilities within the app, where users can set goals and track their progress towards them.

Purpose of Experiment 1

The purpose of this study was to examine the effects of a goal-setting intervention using Fitbit devices on the physical activity level of college students with I/DD. Specific research questions included:

1. What are the effects of goal-setting sessions using Fitbit devices on the physical activity level of college students with I/DD?
2. Do college students with I/DD find value in incorporating goal-setting interventions into the use of a Fitbit device?

Method

Participants

Participants included four college students with intellectual disability and autism who were enrolled in a post-secondary education (PSE) program at a large university in the southeastern United States. The PSE program utilized a hybrid structure where students both audited general college courses and took program-specific courses in career planning, life skills, and digital literacy. Participant ages ranged from 18-23 years old, and pseudo names were used in order to maintain confidentiality. Students were selected to participate in the study based on an identified desire to become more physically fit or to participate in physical activity or on the potential to improve their current physical activity level. Additionally, students were not selected if they already had their own personal Fitbit that they used on a regular basis. All students were familiar with mobile and tablet apps and took a course called Digital Literacy for students in this particular PSE program. Specific student characteristics are included in Table 1 below.

Alexa. Alexa was a 20-year-old female student diagnosed with a learning disability, language impairment, and a full-scale IQ of 69 on the Wechsler Abbreviated Scale of Intelligence (WASI-2), placing her in the "extremely low" range. On her most recent achievement test, the Woodcock-Johnson IV (WJ-IV), Alexa demonstrated relative strengths in oral reading (SS= 96, 41st percentile), spelling (SS=94, 35th percentile), and letter-word identification (SS=90, 25th percentile). She demonstrated an overall weakness in cognitive processing speed with a standard score of 75 (5th percentile).

Alexa was fairly inactive at the start of this experiment. She did not exercise at home or school or participate in any extracurricular activities involving physical activity. In fact, although she agreed to wear the Fitbit and participate in the study, she often commented that she did not enjoy wearing it. During down time on weekends and during the school day, Alexa generally found a place to sit and watch videos on her iPad or phone.

Archie. Archie was a 20-year-old male student with autism and some other global developmental delays, which also result in an orthopedic impairment. His score of a 53 full-scale IQ on the Wechsler Adult Intelligence Scale (WAIS-IV) placed him in the 0.1 percentile. He demonstrated a relative strength in verbal comprehension with a 72 composite score (3rd

Table 1.

Participant descriptions, Study 1.

Participant	Age	Disability	IQ	Woodcock Johnson IV (Standard Scores / Percentile)		
				Cognitive Processing Speed	Basic Reading Skills	Passage Comprehension
Alexa	21	Language Impairment; Learning Disability	69	75 / 5	88 / 21	83 / 13
Archie	21	Autism; Intellectual Disability; Orthopedic Impairment	53	<40 / <01	86 / 17	83 / 13
Carter	19	Autism	70	71 / 3	90 / 26	66 / 1
Elisa	22	Intellectual Disability	49	<40 / <0.1	88 / 21	53 / <0.1

percentile). His academic skills and capabilities are significantly splintered, scoring in the 10th percentile in broad reading (“limited” range), but scoring in the less than 0.1 percentile (“negligible” range) in broad math, math calculation skills, and academic applications).

Archie’s scores on the WJ-IV indicate that that compared to peers of his age, he demonstrates very low cognitive processing speed (SS<40, 0.1 percentile) and low reading skills (SS=86, 17th percentile) and reading comprehension skills (SS=83, 13th percentile). His reading vocabulary skills were demonstrated at a 3rd grade equivalent (SS=66, 1st percentile).

Archie was fairly inactive at the start of this study. He played on a basketball league which played games about once per week during the season, however, that was the extent of his physical activity. During school days, he was generally found in the PSE program offices participating in sedentary activities.

Carter. Carter was a 19-year-old male student with autism. He scored a standard score of a 70 (composite intelligence index) on the Reynolds Intellectual Assessment Scale (RAIS), with his nonverbal score being much higher than his verbal score (85 and 62, respectively). Results from the WJ-IV indicate low cognitive processing speed when compared to peers of his age (SS=71, 3rd percentile), low average basic reading skills (SS=90, 26th percentile), and low passage comprehension skills (SS=66, 1st percentile).

Prior to this study, Carter did not participate in regular exercise. However, he did walk frequently on campus, as most of his classes were far from the PSE offices.

Elisa. Elisa was a 22-year-old female student diagnosed with an intellectual disability as well as a hearing impairment. Her full-scale IQ score was a 49, placing her in the less than 0.1 percentile. She also demonstrated “extremely low” adaptive behavior capabilities in a number of areas at both home and school on the Adaptive Behavior Assessment System, with a relative strength in social skills (50^{th} percentile at home, 3^{rd} percentile at school). Her WJ-IV results indicate that she has a very low cognitive processing speed (SS < 40, <0.1 percentile), very low passage comprehension skills (SS=53, <0.1 percentile), and low average basic reading skills (SS= 88, 21^{st} percentile).

Elisa comes from an active family, with immediate and extended family members who regularly attend group exercise classes, go hiking and walking, and participate in outdoor activities. She enjoys these activities greatly, however, she did not regularly achieve the recommended number of daily steps prior to the start of this study.

Setting

All phases of this study were conducted on the campus of a large, public university in the southeastern United States. The university enrolled around 28,000 undergraduate and graduate students. Participants were enrolled in the PSE program at the university, where they took traditional academic courses as auditors and program-specific courses in career planning, life skills, and digital literacy. Additionally, students participated in a work-based internship for about 8 hours per week. Program staff included university faculty in counselor education and special education, graduate teaching assistants, and a program coordinator. Students were also involved in peer mentoring programs and Best Buddies, both of which facilitated inclusion and assisted students in academic work and social events.

All phases of the study took place on campus. However, since students wore Fitbit devices throughout the day, including after school hours, data were collected both on and off campus.

Materials

A popular wearable activity monitor, a Fitbit Blaze, was used in all phases of the study. This particular type of wearable device only requires that the individual wear the device on the wrist, and it automatically tracks activity level via a triaxial accelerometer (Fitbit Help, 2015). A triaxial accelerometer measures acceleration in three planes: vertical, horizontal, and medial, whereby uniaxial accelerometers measure acceleration in only one plane, usually vertical (Freedson & Miller, 2000). The Fitbit Blaze is able to track number of steps, distance, calories burned, floors climbed, and active minutes, as well as sleep patterns. The participating PSE program and students had access to a set of Fitbit Blazes.

Additionally, the associated Fitbit app was incorporated into this experiment so that participants could actively and independently monitor their own individual activity levels. The app was installed on each student's individual device (school-provided iPad, personal smartphone, personal tablet, or all three) and synced with each individual participant's assigned Fitbit. Students with compatible personal devices were able, but not required, to install the app. The Fitbit app and dashboard allows users to view the total number of steps taken per day, the total distance, total calories burned, total floors climbed, and total number of active minutes (see Figure 2). Users can also manually enter exercise that is not recognized by the Fitbit step count, log and track their weight, view sleep patterns, and track calories eaten and daily water intake.

The Fitbit app also incorporates goal setting. Users are able to set their own goals for activity level (steps taken, distance walked, calories burned, and active minutes), for exercise (number of days exercised in a week), for nutrition and body (water intake, calorie intake, goal weight, and goal body fat percentage), and sleep (time asleep). Users can see progress towards their goals by use of graphs, and can also see visual representation of their progress over time,

Figure 2. Fitbit dashboard showing visual representation of percentage of goal step count and other available options.

When users reach their goal for daily step count, the Fitbit itself vibrates and the screen flashes with celebration-like animation to alert the user that the goal has been met. Additionally, the dashboard on the Fitbit app shows a circle with a percentage of it filled in based on how close to the goal the user was that day. The circle is filled and is green when the user has reached the goal (see Figure 3 below).

Other options for the Fitbit that were not incorporated in this particular study were the ability to add "friends" who also use a Fitbit and have downloaded the app and "badges" that can be achieved. The Fitbit app shows the user's friends ranked in order of number of steps taken over the course of the past seven days. Users are also able to send friends messages, set up "challenges" with friends, cheer friends on, and "taunt" friends. This allows for interaction as well as friendly competitions. Users can also earn "badges" by achieving certain goals. There are badges for certain number of steps in a day, total lifetime steps, total lifetime miles, total floors climbed in a day, etc. The app automatically awards these badges once the individual achieves each particular goal. For the purpose of this particular study, only the goal setting and dashboard functions of the Fitbit app were used.

Individual Fitbit chargers were also required. These were housed in the lead researcher's office, which was located in the PSE program offices on campus. Individual Fitbit devices were collected on Friday to charge for the weekend, and re-distributed on Monday morning.

Variables and Data Collection

The dependent variable in this experiment was the number of steps taken each weekday as measured by each student's assigned Fitbit. It was measured starting on Monday when the students arrived at school until Friday when the students left school. Students were provided their assigned Fitbit at the time they arrived at school on Monday morning, which was the same

Figure 3. Fitbit dashboard showing green, filled circle representing that the daily step count goal was achieved.

for each student from week to week. The independent variable was a goal-setting intervention that was implemented in a series of treatment phases; in each phase, the criterion rate was changed for the target behavior.

The dependent variable (number of steps taken per weekday) was measured by each individual participant's assigned Fitbit. Measured steps were then viewable on the app for each participant's assigned iPad or other mobile device. At least once per week, the lead researcher transferred individual participants' daily number of steps to a data collection form, housed in a Google spreadsheet only accessible to the lead researcher.

The goal-setting intervention was completed in individual sessions. Goal-setting sessions were completed one time prior to each specific treatment phase. Students sat down with the lead researcher to review their activity levels for the preceding treatment phase as defined by the number of steps taken per day. Student and lead researcher viewed the data provided by the app in order to have a visual representation of the student's activity levels. These data and accompanying graphs were also available by logging in at www.fitbit.com. The researcher and student then brainstormed together to find trends or patterns and determine whether additional activities could increase the number of steps taken each day. They also discussed recommended number of steps per day. The researcher and student determined together a goal number of steps to take each day based, on average, on a 10% increase of the average number of steps from the previous phase (Croteau 2004). This was not always exact, as the goal step count was determined by a number of factors; however, an increase of 10% was a major factor that was considered when making this determination.

Once the goal number of steps had been reached and was stable and consistent for at least 3 days (Horner et al., 2005), another goal-setting session was conducted, and the criterion for the next phase was changed. This was completed for at least three replications, although time constraints (end of semester) made this a challenge for some students. Criterion changes varied with each phase based on individual goals. Total number of steps taken throughout baseline and in each separate phase was graphed for visual analyses.

Procedures

Baseline. During the baseline phase, each participant wore a Fitbit without seeing the tracked number of steps taken each day. They were encouraged to notice their step count on the device as well as on the app and to take as many steps as they normally would. The lead researcher explained to the students that within a few weeks, they would complete a project with the Fitbits. Data were collected until stability was observed. Stability was determined using Gast's (2010) "80%-20%" criteria, or if 80% of the data points fell on or within 20% of the median baseline value, then the data were considered to be stable. The Fitbit app was installed on individual participant's iPads and/or smartphones, so students were able to view the app and the corresponding data if they so desired. However, no feedback was given on number of steps taken, nor were students encouraged to use the app or track their steps.

Training in Fitbit app. Participants were then trained in the use of the Fitbit and the corresponding app. They were also asked if they would like to install the app on their own personal smartphone or table, and assistance was provided if needed.

The researcher provided instruction to individual participants on each aspect of the Fitbit app. Prior to this instruction, students had participated in lessons on calories burned, activity levels, the importance of physical activity, and ways to increase fitness levels during the Life Skills course that was taken as part of the PSE program. The lead researcher first reviewed the data from her own Fitbit app, explaining how to find and interpret number of steps taken, whether the battery was low and needed to be charged, how many miles walked each day, how many calories burned, number of active minutes, and sleep patterns. For purpose of this experiment, the categories of sleep patterns, calories eaten, and water intake were not considered.

Individual students were then able to review their own Fitbit app and were provided assistance in finding and interpreting number of steps taken, whether the battery was low and needed to be charged, how many miles walked each day, how many calories burned, and number of active minutes Students continued to review the Fitbit app and device with the lead researcher until all students were able to access and operate the app and device functions independently.

Intervention: goal-setting session. Following initial training, participants completed individual goal-setting sessions with assistance. All of the sessions were completed in one-on-one settings with the lead researcher.

During the first of these sessions, participants reviewed their baseline data individually with the lead researcher. Together, the participant and lead researcher reviewed data and accompanying graphs that were available by logging in to each individual student's account on www.fitbit.com. The lead researcher then completed a shared spreadsheet via Google Drive that tracked number of steps taken per day during the baseline phase, average number of steps taken per day during the baseline phase, recommended number of steps per day, typical activity level during days tracked during baseline, and any other relevant notes. Based on that information, the participant, along with assistance from the lead researcher, determined an appropriate, individualized goal number of steps to take per day for the next phase of treatment relative to the individual's baseline values (Tudor-Locke et al., 2011), increasing the goal number of steps by, on average, 10% of the average number of steps from the previous phase. The lead researcher guided the student to a plan that would enable him or her to achieve that goal. The student's Fitbit app was then updated accordingly with the new goal number of steps.

Once the number of steps was stable and consistent over the course of at least 3 days, another individual goal-setting session was conducted, where step count data and accompanying graphs from the Fitbit app and www.fitbit.com were reviewed. This was repeated for three replications. Individual goals dictated the criterion changes and in order to conduct another goal-setting session and move on to the next phase, the student must have achieved the goal for 3 consecutive data collections.

Experimental Design

A changing criterion design (Gast & Ledford, 2010b) was implemented in order to determine the effectiveness of a goal-setting intervention on individual students' number of steps taken during the school day. In this type of design, baseline data are collected for a single target behavior. The treatment program is then implemented in a series of treatment phases, each of which corresponds with a change in criterion rate for the target behavior. So, each phase serves as the baseline for the next phase.

In this type of design, control is demonstrated by showing a change in the dependent variable when the criterion level is changed (Gast & Ledford, 2010b). This change should be immediate and should follow a stable trend at the prior criterion level. Changing criterion designs are particularly useful when evaluating programs that are "designed to shape behaviors that are in a person's repertoire but do not occur at an acceptable rate" (p. 385).

In this particular experiment, data were collected at each criterion level without requiring a withdrawal condition. Criterion levels were determined at each goal-setting session throughout the experiment. Hartmann and Hall (1976) recommended that a strategy for determining criterion levels be determined before initiating the study. As such, this experiment defined criterion levels based on decisions made during individual goal-setting sessions. Once the number of steps was stable and consistent over the course of at least 3 days, another goal-setting session was conducted, where step count data and accompanying graphs from the Fitbit app and www.fitbit.com were reviewed. This was repeated for three replications, and in order to move on to the next phase, the student must have achieved the goal for 3 consecutive data collections.

Data Analysis Procedures

Visual analysis procedures were utilized in order to evaluate the effect of the changing criterion goal-setting intervention on individual's number of steps taken each school day. Six indicators were used to examine within- and between-phase data patterns and to assess the effects of the intervention: (a) level, (b) trend, (c) variability, (d) immediacy of the effect, (e) overlap, and (f) consistency of data patterns across similar phases (What Works Clearinghouse, 2014). Within-phase comparisons were evaluated to assess predictable patterns of data. Data from adjacent phases were used to assess whether manipulation of the independent variable was actually associated with a change in the dependent variable. Finally, data from all phases were examined to determine whether a functional relation was present (Gast, 2010). A functional relation was determined when at least three occurrences of an effect after a minimum of three different points in time were observed (Horner et al., 2005).

Other statistical measures can corroborate visual analysis results, providing greater confidence and a quantifiable analysis, showing the magnitude of the effect (Campbell & Herzinger, 2010). A common analysis calculated during single-case methodology is effect size to determine the efficacy or effectiveness of the study. The most common calculation of effect size is percentage of non-overlapping data (PND), which calculates percentage of data that do not overlap between the baseline and following intervention phases (Scruggs, Mastropieri, & Casto, 1987). It is easy to calculate, in alignment with the tradition of visual analysis in single case design, and demonstrates intuitive appeal (Campbell & Herzinger, 2010, p. 442). Scruggs and Mastropieri (2001) crafted interpretational guidelines for PND, specifically, that PND greater than 90% is a highly effective intervention, PND greater than 70% but less than 90% is an effective intervention, PND greater than 50% but less than 70% is a questionably effective intervention, and PND less than 50% demonstrates unreliable effectiveness for interventions. In this experiment, the percentage of non-overlapping data (PND) was calculated for each participant between the baseline and intervention phases.

Interobserver Agreement (IOA) and Procedural Reliability

The lead researcher, a doctoral student in special education, trained a research assistant, an undergraduate student, to collect interobserver agreement (IOA) and procedural reliability data.

IOA data were collected during a minimum of 20% of baseline and intervention conditions for each individual participant. A research assistant was trained in the study's data collection procedures. Both the lead researcher and research assistant reviewed each participant's step count data. The percentage of IOA was calculated for each participant by adding the number of agreements between observers (agreement on the outcome variable) and divided by the total number of agreements and disagreements combined, then multiplying by 100%. Reliability was defined as 90% or greater. If IOA fell below 90%, the two observers would have reviewed all daily step counts together. The percentage of IOA was 100%.

Procedural reliability/treatment integrity data were collected during at least 20% of baseline and goal-setting sessions for each participant. The researcher assessed this by providing the observer a procedural reliability form to complete during direct observation (See Appendix A). This form included a list of what was to be included during each goal-setting session between criterion changes: review of baseline data or data from the previous phase, computation of averages, goal number of steps for next phase determined, discussion and corresponding notes on how to attain the new goal, and Fitbit app updated to reflect new goal number of daily steps.

Procedural reliability was calculated by dividing the number of observed activities that took place during a goal-setting session by the number of planned activities that were to take place during a goal-setting session and multiplying by 100. Procedural reliability was defined as 90% or greater. If it was lower than 90%, the research team met to clarify procedures. The overall mean for procedural reliability was 95% (range = 90% - 100%). Alexa's treatment integrity was 100%; Archie's treatment integrity ranged from 90% to 100% (*M* = 95%); Carter's treatment integrity was 100%; Elisa's treatment integrity ranged from 90% to 100% (*M* = 95%).

Social Validity

After the intervention phases had been completed, social validity was assessed via a Likert-type survey (see Appendix B). This was created by the lead researcher to assess participants' opinions and thoughts on the use of a Fitbit, the use of goal setting, how it helped (or did not help) their fitness and activity levels, and whether they felt that they would continue to monitor their activity levels after the intervention was completed.

Students were given the option to have individual questions read aloud to them, and each item ranged from 1 (strongly disagree) to 5 (strongly agree). The questionnaire also included open-ended questions to allow students to give additional information if desired. These answers were scribed by the lead researcher if needed.

Results

Baseline results indicated that most students generally achieved less than the typically and traditionally recommended 10,000 steps per day (Tudor-Locke & Bassett, 2004). Baseline also indicated that participants' inconsistent school schedules led to inconsistent step counts from day to day. Low and inconsistent step counts indicated that students were not initially concerned with or attached to their step counts. While the extent of improvement varied across students, visual analysis procedures for all participants across phases suggested that the goal-setting intervention was an effective way to improve step counts and assist students in finding more consistency from day to day. Results for individual participants are discussed in detail below, as are effect size averages.

Alexa. Alexa made strong overall improvements across the goal-setting interventions throughout the semester (see Figure 4). During baseline, Alexa averaged 3386 steps per day. Alexa's step counts were very inconsistent, ranging from 453 total steps at the lowest to 6012 total steps at the highest. Alexa's total baseline phase took several weeks, as there were many days where she left her Fitbit at home or did not put it on until later in the day. For this reason, the lead researcher made the decision to move on to the goal-setting phase of the intervention before stability was achieved.

While her average step count during baseline was 3386 steps, Alexa had one day where she took 5615 steps and another day where she took 6012 steps. At the initial goal-setting session (between baseline and goal 1 phase), Alexa and the lead researcher made the joint decision to set her first goal at 5000 steps. At this time, Alexa indicated that she would wear her Fitbit consistently, from the start to the finish of each day.

During goal 1 phase, Alexa averaged about 5286 steps, achieving her goal of 5000 steps

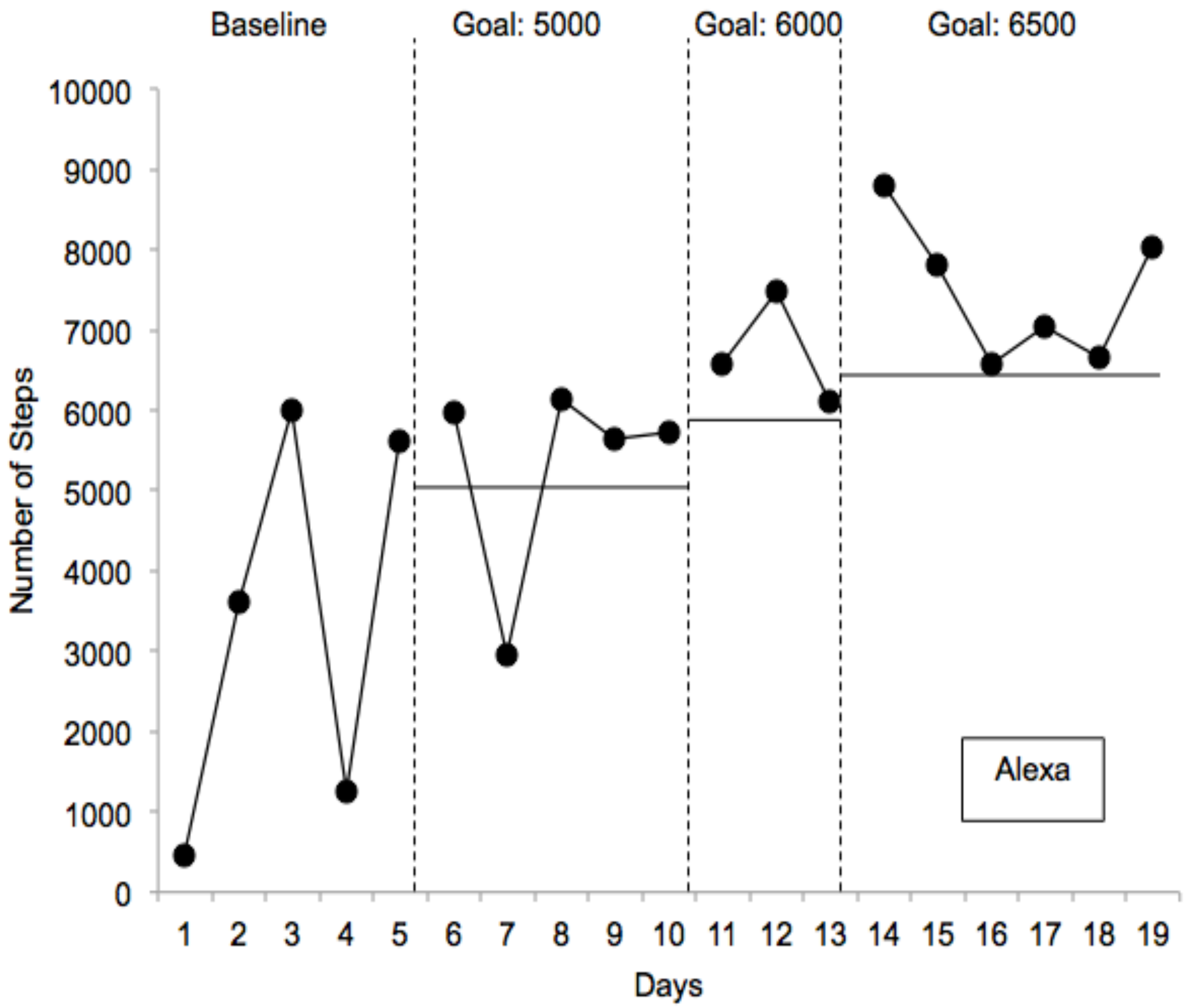

Figure 4. Alexa's total number of steps during baseline and across goal-setting phases; the horizontal line represents the goal step count for that phase.

daily. This was a 56% improvement over her baseline average. After 3 consecutive data points at or above her goal, Alexa and the lead researcher set her goal for 6000 steps. They had originally decided to set it at 5500 steps, however, Alexa asked if she could push herself and set it a bit higher. At this time, Alexa started to see great improvements in consistency of her daily step count. She went from averaging 5286 steps per day in goal 1 phase to averaging 6719 steps per day in goal 2 phase. The goal 2 phase average of 6719 steps was a 427% improvement over the average from goal 1 phase of 5286 steps and a 98% improvement over her baseline average of 3386 steps. Additionally, reports from the lead researcher indicate Alexa wore her Fitbit more consistently (did not take it off during the school day) and began sharing her step count with her peers, teachers, and family.

After reaching her 6000-step goal for three consecutive days, Alexa and the lead researcher made the decision to set her goal for 6500 steps for goal 3 phase. She achieved this over four days, even far exceeding her goal step count by taking as many as 8796 steps on the first day of this phase. Her average step count in the final, goal 3 phase also exceeded her goal, with an average of about 7488 steps each day of that phase. During this final phase, Alexa took six total days in order to reach three consecutive days at her goal. This was an improvement of 11% over goal 2 phase's average of 6719 steps and a 121% improvement over baseline average of 3386 steps.

Effect size across goal-setting phases was measured in terms of percentage of non-overlapping data (Scruggs et al., 1987). From baseline to the goal 1 phase, Alexa's percentage of non-overlapping data was 20%, which indicates unreliable effectiveness (Scruggs & Mastropieri, 2001). From goal 1 phase to goal 2 phase, her percentage of non-overlapping data increased to 66.67%, indicating a questionably effective intervention. This continued to increase, moving to

83.33% between goal 2 phase and goal 3 phase, indicating an effective intervention. The most notable effect size occurred from baseline phase to the final goal 3 phase, with 100% non-overlapping data, suggesting that the intervention was highly effective. It should again be noted that Alexa demonstrated great variability in her step count from day to day, making consistent step counts a challenge. For this reason, Alexa's percentage of improvement from phase to phase and from baseline to goal 3 phase should be given greater weight than the effect size calculations.

Overall, the most clear improvement in average daily steps taken can be seen during visual analysis of Alexa's data as well as when computing the percentage of improvement from phase to phase.

Archie. Figure 5 displays Archie's data. Archie saw overall improvements in average step count from phase to phase, starting with an average of about 4657 steps per day in baseline and finishing with an average of about 7927 steps per day in the goal 3 phase, a 70% improvement. Archie started out highly inconsistent and usually achieved a much lower step count than the recommended 10,000 steps per day (as low as 2751 total steps). Over each phase, however, visual analysis confirms that he was able to improve his average step count as well as become more consistent.

Archie's step counts during baseline were highly inconsistent, taking a longer time to reach some level of stability before starting the goal-setting intervention. Archie averaged about 4657 steps in baseline, and the first goal was set for 5500 steps after a decision by both Archie and the lead researcher. Archie immediately responded to this goal, achieving much higher than 6000 steps for three consecutive days and averaging 6546 steps in this phase, an improvement of 43% over his baseline average. The goal for the goal 2 phase was set at 7500 steps, and an effect

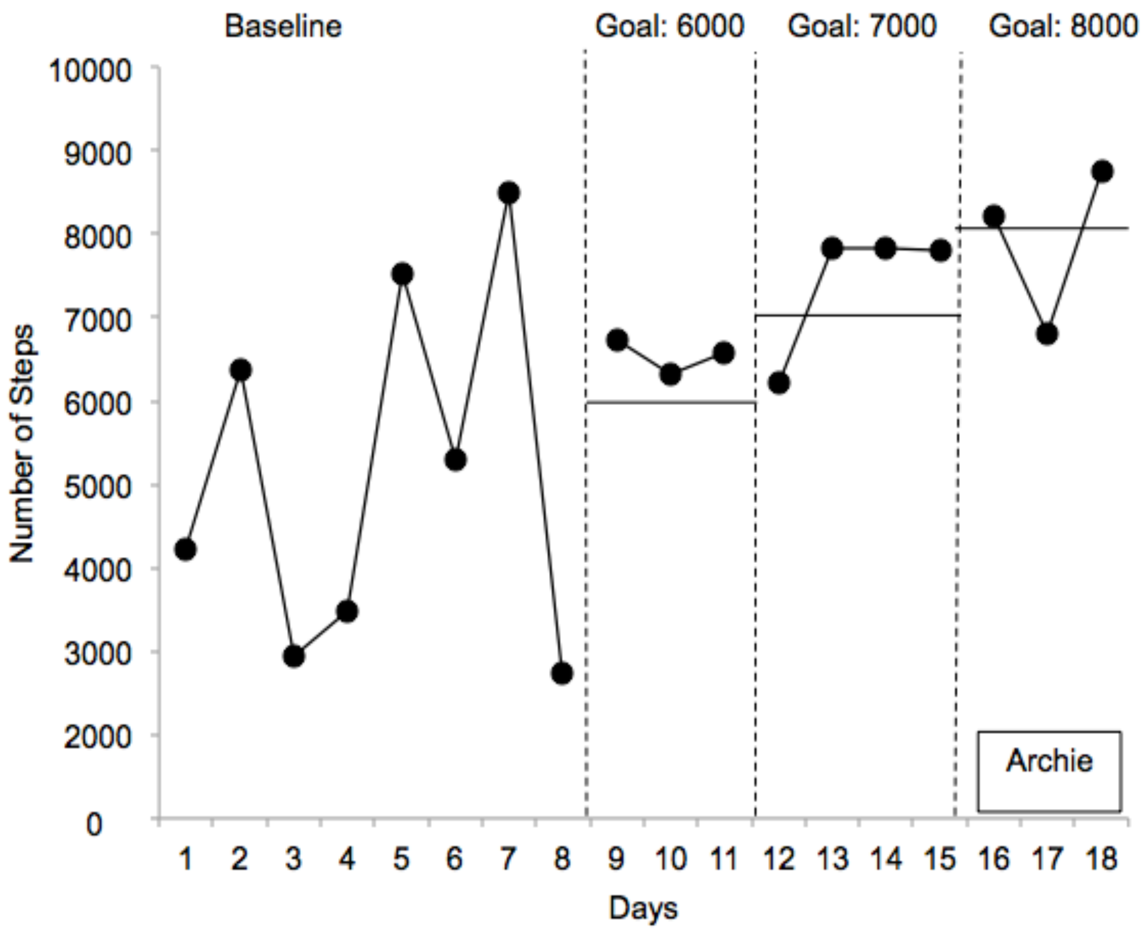

Figure 5. Archie's total number of steps during baseline and across goal-setting phases; the horizontal line represents the goal step count for that phase.

for this was seen almost immediately, as well. On the first day of this phase, Archie achieved 6209 steps, but then reached the 7000-step goal for the three days following that. While he achieved the goal for three consecutive days, his average step count in this phase was 7417 steps and therefore did not reach the goal. However, the 7417 average was an improvement of 13% over the goal 1 phase average of 6547 steps and of 62% over his baseline average of 4657 steps.

For the final, goal 3 phase, Archie and the lead researcher set his goal for 8000 steps, which he was able to achieve for two days, albeit not consecutively. At that time, the school semester ended, so he was not able to continue working towards this goal. His step count average for the final phase was about 7928 steps, which was still a strong, 7% improvement over the 7417 average from the preceding phase and a 70% improvement over his baseline average of 4657 steps.

Effect size across goal-setting phases was measured in terms of percentage of non-overlapping data (Scruggs et al., 1987). From baseline to the goal 1 phase, Archie's percentage of non-overlapping data was 0%, which indicates unreliable effectiveness (Scruggs & Mastropieri, 2001). It should be noted here that during baseline, Archie had one day during which he achieved a significantly higher step count than he did on the other days of baseline. If this point were not included, Archie would have had 66.67% non-overlapping data. From goal 1 phase to goal 2 phase, his percentage of non-overlapping data increased to 75%, indicating an effective intervention. Between goal 2 phase and goal 3 phase, Archie achieved 66.67% non-overlapping data, indicating a questionably effective intervention. Percentage of non-overlapping data between baseline and goal 3 phase was also 66.67%, indicating a questionably effective intervention overall. Again, inconsistency and variability of step counts should be noted. Like Alexa, the percentage of improvement from phase to phase as well as from baseline to the final phase, in addition to the improvement in consistency of daily step counts over time, should be given greater weight than the effect size calculations here. A graph of Archie's step counts throughout all phases can be found in Figure 5 below.

Carter. Overall, Carter responded well to the goal-setting intervention and to tracking his physical activity in general (see Figure 6). He averaged 9327 daily steps during the baseline phase, with most data points falling somewhere in the 8000-range (8888, 8675, and 8815, respectively). In the fourth and final phase, he averaged 14108 steps, which was a 50% improvement over his baseline average.

After baseline, Carter and the lead researcher set his goal for 10000 steps per day. He achieved this goal immediately, as the first day following baseline, he achieved 12543 steps. This was inconsistent for several days, ranging from 5384 steps to 15049 steps, but variability from day to day became less frequent after a week or so. In goal 1 phase, he averaged about 11516 steps, which was a 23% improvement over his baseline average of 9327. Because of inconsistency, it took Carter seven days in order to achieve his goal for three consecutive days. Once he reached his goal for three consecutive days, Carter and the lead researcher set a goal of 12,000 steps, which he immediately reached and was able to maintain (14046 steps on the first day of goal 2 phase). His average step count in this phase was 13457, which exceeded the 12000-step goal and was a 17% improvement over the preceding phase's average step count. Further, this was a 44% improvement over Carter's baseline step count.

At this time, Carter wanted to continue to set higher goals and improve his step count, despite the fact that he had already met and even exceeded the recommended 10,000 daily steps. Carter and the lead researcher set a goal for 14000 steps per day at this time. He fluctuated at this goal, achieving as many as 16927 steps and as few as 10494 steps, but did reach the goal for

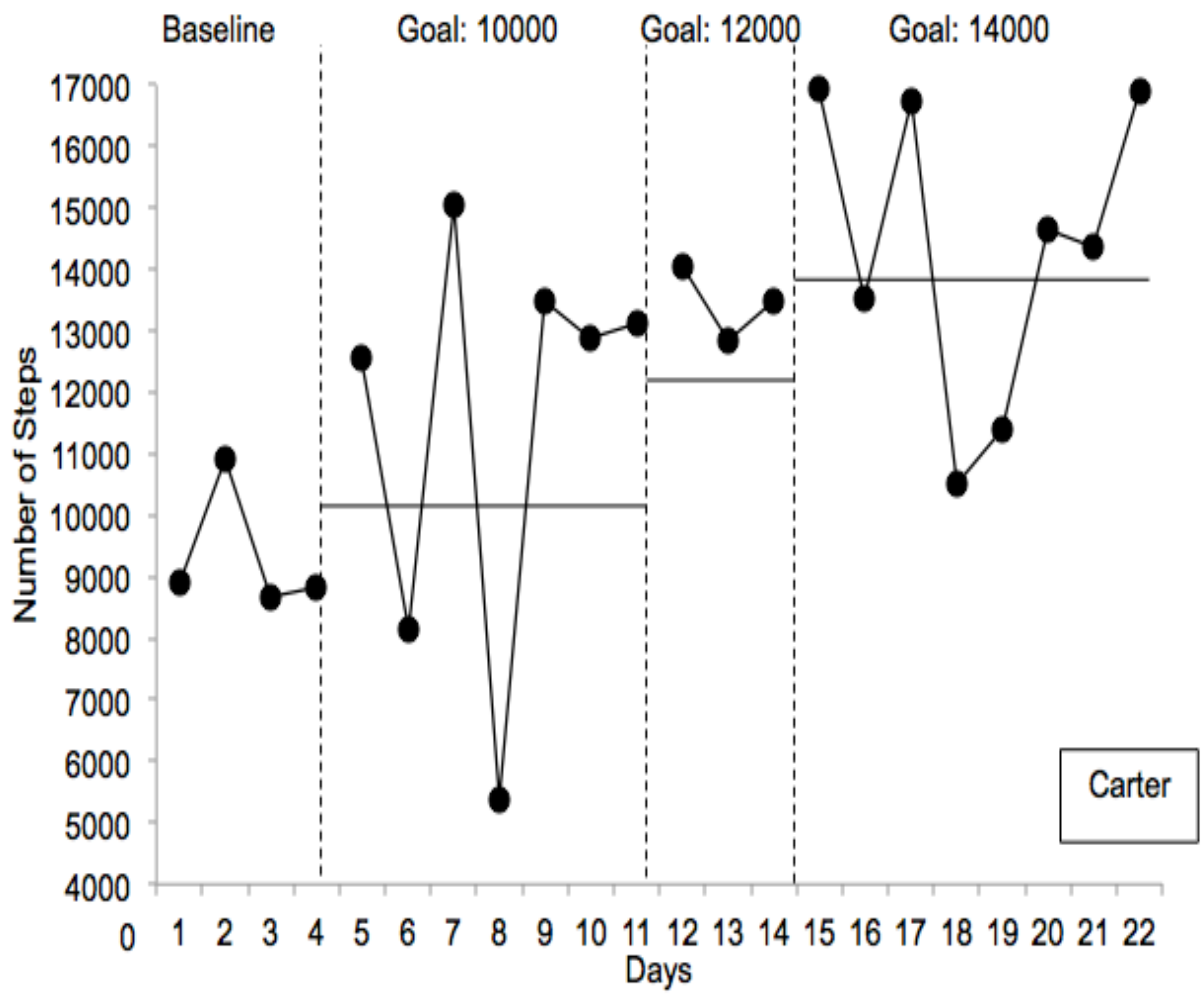

Figure 6. Carter's total number of steps during baseline and across goal-setting phases; the horizontal line represents the goal step count for that phase.

three consecutive data collections, averaging 14379 steps per day during this phase. The average for this phase was a 7% improvement over the prior phase and a 54% improvement over his baseline average of 9326 steps.

Effect size measures across goal-setting phases as measured by percentage of non-overlapping data indicated that the intervention was effective (Scruggs & Mastropieri, 2001; Scruggs et al., 1987). Between baseline phase and goal 1 phase, Carter's percentage of non-overlapping data was 71.4%, indicating an effective intervention. From goal 1 to goal 2 phase, Carter's percentage of non-overlapping data was 0%, indicating questionable effectiveness. However, during goal 2 phase, Carter had one day in which he took a significantly higher number of steps than he did on the other days (15049) and he was not able to reach this number during goal 3 phase, even though his overall average step count improved by 17%. From goal 2 phase to goal 3 phase, the percentage of non-overlapping data increased to 62.5%, indicating a questionably effective intervention. The most notable effect size was overall between baseline and goal 3 phase, where Carter achieved 87.5% non-overlapping data. Carter's step counts across phases can be seen in Figure 6 below.

Elisa. Elisa's results are displayed below in Figure 7. Elisa saw an improvement of 96% in average steps from baseline until the end of goal 3 phase. It typically took her a longer period of time to achieve her goals, however, she was able to successfully progress through each criterion change.

During the baseline phase, Elisa averaged 4989 steps per day. She had one day during this phase where she achieved 10331 steps, however, she indicated that it was a day where she took several fitness classes at home that evening. Elisa and the lead researcher set her first goal for 6000 steps per day. While it took 11 days of data collection for Elisa to achieve the goal for

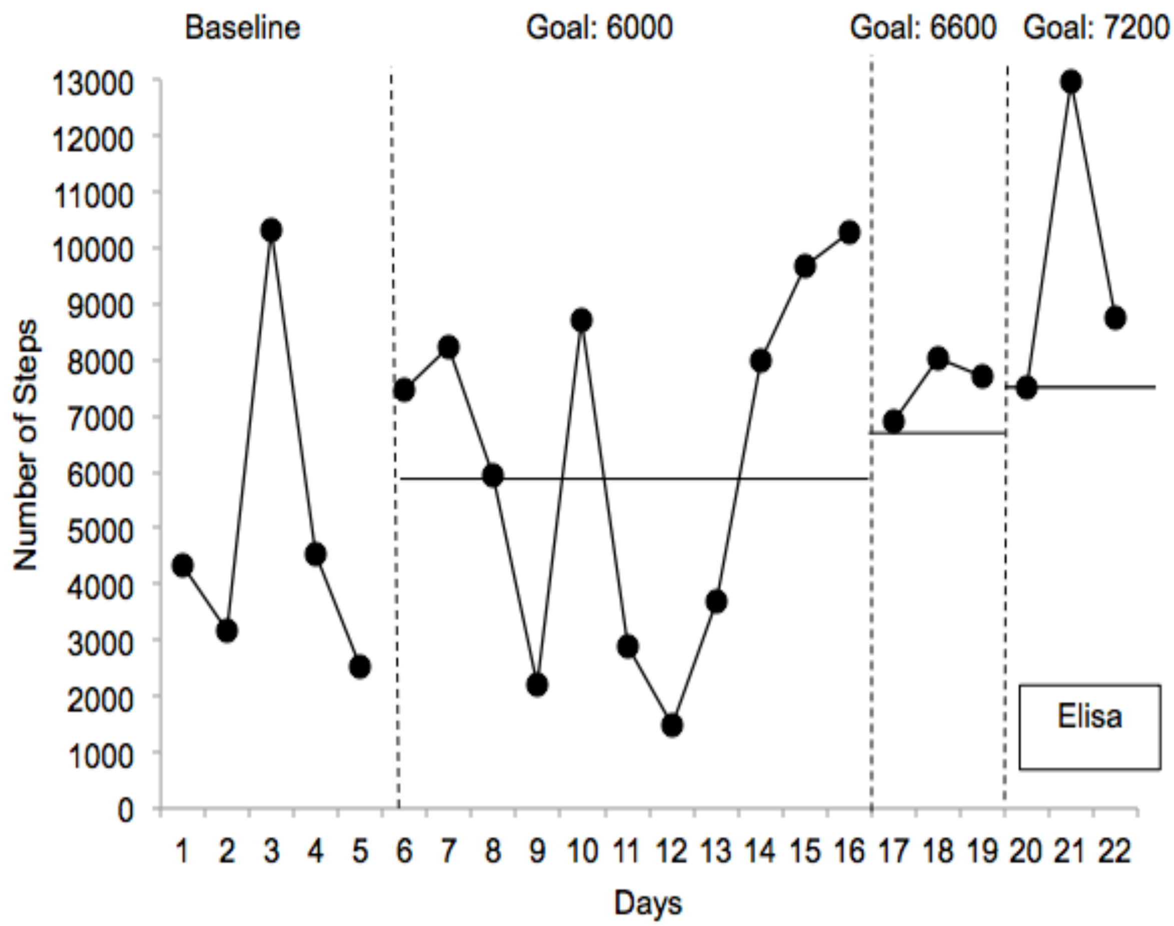

Figure 7. Elisa's total number of steps during baseline and across goal-setting phases; the horizontal line represents the goal step count for that phase.

3 consecutive days, she averaged 6232 steps per day during this phase. This was a 25% improvement over her average step count from baseline phase.

At this time, Elisa and the lead researcher set her goal for 6600 steps, which would mean an improvement of 10%. She achieved this goal immediately, which indicated that by that time, Elisa was starting to become invested and interested in the goal-setting intervention and in her step count. Her average step count during this phase was about 7534, which was an improvement of 21% more steps than the preceding phase, and 51% more average steps than the baseline phase average of 4989 steps.

During the final, goal 3 phase, the goal was set at 7200 steps per day. Elisa achieved this immediately, with 7516 steps on the first day at this goal. She continued to improve her step count and averaged about 9756 steps during this final phase. This was an improvement of 29% over the preceding phase and of 96% over her baseline average.

Effect size as measured by percentage of non-overlapping data indicated that this was an unreliable intervention for Elisa (Scruggs & Mastropieri, 2001; Scruggs et al., 1987). The percentage of non-overlapping data between both baseline phase and goal phase 1 and between goal phase 1 and goal phase 2 was 0%. However, visual analysis shows that Elisa demonstrated great variability throughout the intervention, and often had days where she achieved much higher step counts than others. For example, during both baseline phase and goal phase 1, Elisa achieved over 10000 steps for at least one data collection, while during goal phase 2, she did not achieve 10000 steps in a day but did achieve much greater consistency overall. The greatest effect size for Elisa occurred between goal 2 phase and goal 3 phase, with a 66.67% percentage of non-overlapping data. Baseline phase to goal 3 phase percentage of non-overlapping data was

33.33%, indicating unreliable effectiveness. However, it should be mentioned that all three data points in goal 3 phase were higher than all but one data point during baseline phase.

Effect size. Overall effect size averages across participants were also measured**.** While effect size interpretations are better when considered on an individual basis, the overall effect size shows that the greatest percentage of non-overlapping data occurred between baseline phase and goal 3 phase (M=71.88), indicating an effective intervention. This was higher than the effect size between goal 2 phase and goal 3 phase (M=69.79), between goal 1 phase and goal 2 phase (M=35.42), and between baseline and goal 1 phase (M=22.85). This can be interpreted to demonstrate that as participants spent more time setting step count goals, they were able to increase their step counts without as much variability from day to day.

Social Validity Results

At the conclusion of the study, all participants completed a questionnaire about the usefulness and value of the Fitbit and goal-setting sessions (Appendix B). The questionnaire consisted of 14 questions that incorporated a 5-point Likert-type scale and 3 open-ended questions. Overall, students reported positive thoughts about the Fitbit and goal setting in general. Results indicated that all four participants either agreed or strongly agreed that they (a) liked used a Fitbit to track activity level, (b) felt that using the Fitbit was helpful to keep track of physical activity, (c) felt that the Fitbit app was easy to use, (d) liked setting goals for number of steps, (e) liked setting goals and wanted to set goals in other areas of their lives, as well, and (f) wanted to keep setting goals. The only item on the questionnaire on which not all of the students generally agreed or were neutral was that they wanted to keep using a Fitbit (Alexa said that she was neutral about this while Elisa said that she slightly disagreed). However, both Alexa and Elisa requested to use Fitbits again in the spring semester, and Elisa even received her own Fitbit for her birthday. The open-ended questions on the questionnaire indicated that participants were happy with the use of the Fitbit. Table 2 below includes specific responses.

It should also be noted that several participants became very active with their Fitbits over the course of the study. One participant in particular, Elisa, seemed to find the intervention more acceptable than the other students. On a number of occasions throughout the study, Elisa texted the lead researcher to let her know when she had reached her goal for the day. The texts included screenshots from the Fitbit app so that the lead researcher could see the visual representation of Elisa's achieved goals. Elisa also texted the lead researcher to let her know how she was able to get her goal number of steps (for example, "dancing in my mom's office" and walking to Starbucks for hot chocolate). She took great pride in wearing the Fitbit, even going so far as to ask her family for a Fitbit for her birthday (which she received).

Alexa also became much more engaged with the device and with the intervention over the course of the study, especially towards the end. She texted the lead researcher twice in the final 2 weeks of the study with a screenshot of the Fitbit app indicating that she had reached her goal for the day. Alexa also reported that she and her parents started doing activities together in the evenings, as they also had activity trackers. A fifth student, who started as a participant but, for various reasons, did not finish, asked for and received a Fitbit for Christmas.

Table 2

Individual participant responses to social validity questionnaire, Study 1.

Student	**Questions**		
	Open-ended Question 1: What did you like or not like about the Fitbit and the Fitbit app?	Open-ended Question 2: What was it like to use the Fitbit and the Fitbit app?	Open-ended Question 3: Any other thoughts about the Fitbit, goal setting, or physical activity?
Alexa	"Not reaching my goals was one thing that I didn't like about my Fitbit."	"It was an interesting experience because I've never used the app before."	"I do not have any other thoughts."
Archie	"I liked when it told you when you got your steps in."	"It was easy and fun."	"Thought it was really easy."
Carter	"It's like a watch. I love that watch."	"See how many goals I got every day or night. It's like a new record."	"I like to see how many points. Each time I walk, the steps keep on counting!"
Elisa	"I like it so far. I like keeping track of my steps."	"I check my app every day."	"I like being active."

Discussion

The purpose of this study was to examine the effects of a goal-setting intervention using Fitbit devices on the physical activity level of college students with I/DD by determining whether the intervention was effective in increasing physical activity and whether the students found value in the intervention. All participants were able to improve their physical activity levels as measured by the Fitbit device while setting step count goals over time. Moreover, students were generally able to achieve greater consistency in day-to-day step counts throughout the intervention.

While previous research in using self-management strategies to improve physical activity levels for individuals with I/DD is limited, the findings here certainly support it. It continues a line of research from a handful of previous studies that tracked activity level of individuals with I/DD via accelerometers or pedometers (e.g., Bodde et al., 2013; Frey et al., 2005; Phillips & Holland, 2011; Stanish 2004; Stanish & Draheim, 2005; Stanish & Draheim, 2007; Temple et al., 2000; Temple & Walkley, 2003). It also supported a finding from Todd and Reid (2006) that students with autism could improve physical activity levels with a self-monitoring intervention, and a finding from Coleman and Whitman (1984) that individuals from this population could make improvements in exercise behavior with the use of self-monitoring and self-reinforcement.

Further, the research here supports one "best practice" of implementing multi-component interventions and programs in order to promote physical fitness (e.g., Abdullah et al., 2004; Bazzano et al., 2009; Havercamp et al., 2004; Marks et al., 2013; Stanish & Frey 2008). By incorporating the combination of age- and socially-appropriate technology (i.e., the Fitbit and corresponding app) and well-known self-management strategies (i.e., goal setting) into the students' PSE program, this intervention effectively increases awareness of physical activity and improves physical activity levels.

The results from this study extend the current research base in a number of ways. The primary way in which these results extend the base is that presently, there is limited general research for health, fitness, and physical activity for adults with I/DD (e.g., Rimmer, 1999; Spanos et al., 2013; Stanish & Frey, 2008; Temple et al., 2006). Specifically, there is little to no research supporting the use of wearable technology to improve physical activity in this particular population. This study extends the research by indicating that wearable technology is an appropriate and effective strategy to increase step counts of individuals with I/DD and, in turn, improve their physical activity levels.

Additionally, this research extends the base of research that indicates that self-management strategies, including goal setting, can be used to increase physical activity. While there have been a number of studies demonstrating that self-management strategies, including goal setting, can increase physical activity, most of this research has been for individuals without disabilities (e.g., Baghurst et al., 2015; Consolvo, Klasnja, McDonald, & Landay, 2004; Munson & Consolvo, 2012). Stanish and Frey (2008) identified goal setting and motivational strategies as two appropriate strategies to incorporate when developing health and fitness interventions for this population, so this study applies that suggestion and demonstrates its effectiveness.

These findings also extend the current research in that they suggest that self-management strategies are an effective method to positively influence participation in and persistence towards health behaviors, two ideas that were identified by Bartlo and Klein as needing further exploration (2011).

Further, this extends the research by providing students with I/DD a way to effectively take control of their own physical activity through the use of a wearable device, thus promoting self-determination (Wehmeyer 1999). Stanish and Frey's strategies (2008) also included allowing participants to choose their own activities and make their own decisions during fitness-promoting activities. By allowing participants to monitor and manage their physical activity through daily step counts, they were able to make their own decisions as to how they could achieve their goal to get more steps each day, thus promoting self-determination. This extends research from studies such as from Silva et al. (2010), who determined that when individuals have choice over the type of physical activities in which they participate, they are more likely to develop self-determined motivation towards physical activity. The research here extends this by indicating that this finding is also true for individuals with I/DD.

Finally, the participants strongly indicated that using a wearable technology was socially acceptable. This, along with the accessibility of the Fitbit and the students' desire to continue to wear the Fitbits, suggests that students are likely to continue to keep track of their daily step counts and pay greater attention to their own physical activity levels.

Limitations

The most notable limitation of this study, and a limitation for all single subject designs, was the small sample size (n = 4). Generally speaking, a small sample size limits external validity and generalizability. Additionally, all of the participants came from similar educational backgrounds and similar socioeconomic status, making it difficult to generalize the results of this study to other samples (for example, to young adults with I/DD who are not students in a PSE or who have more or less significant cognitive disabilities than the present sample). Based on the results of this research, it is difficult to predict results of future studies.

A changing criterion design also has an inherent limitation, in that control was demonstrated via a somewhat subjective decision that must be made by the researcher based on data up until that point. For this reason, exact replication is difficult, if not impossible, since the data for each individual participant varied throughout the study.

Another limitation was the frequent lack of data stability. Participants' school schedules were inconsistent, which made data stability (in particular, baseline data stability) and data collection in general a challenge. Some days, students had classes throughout the school day at various locations around campus (meaning a great deal of walking took place, resulting in a higher daily step count), while other days, students had only one class in one building (meaning less walking took place, resulting in a lower daily step count).

Future Studies

Results from this research support goal setting through the use of wearable technologies such as the Fitbit to facilitate improvement of physical activity levels for students with I/DD. Additional, similar studies which allow students to set their own goals for physical activity would be beneficial in determining whether these results can and should be generalized to other settings and other populations. Future research should include more varied participants: for example, participants who are not students in a PSE, from different backgrounds, of different ages (e.g., adults and younger children), and from different geographic locations. Future studies could also implement this intervention with different types of wearable activity monitors that use persuasive technology to track physical activity. Finally, future research on similar interventions using a larger sample size and a control group for comparison would greatly increase external validity.

Summary

Improving step counts is one of many ways to track and measure individual physical activity and thus improve overall health and fitness. Providing students with intellectual and developmental disabilities a way to do this that is socially acceptable and that promotes independence is a way to incorporate physical activity into their daily routine and eventually increase physical activity levels. Students with I/DD tend to be less active and are at greater risk for health problems that are often associated with lack of exercise. By taking small steps to improve physical activity levels, we can hope that these findings will eventually result in better overall health for this population.

Chapter 3

Experiment 2: Using Social Reinforcement to Increase Physical Activity of College Students with Intellectual and Developmental Disabilities

Adults with I/DD tend to be more overweight and less physical active than does the general population. A greater percentage of adults with I/DD are obese than are adults without: 38.3% compared to 28% (Hsieh et al., 2014). Morbid obesity is also more prevalent in adults with I/DD than it is in those without (7.4% vs. 4.2%), and women with I/DD and individuals with Down Syndrome are even more likely to be obese (Bodde et al., 2013; Hsieh et al., 2014; Rimmer & Yamaki, 2006).

It is well known that obesity can be prevented and healthy weight can be maintained through physical activity (CDC, 2014). National physical activity guidelines recommend that adults participate in regular physical activity, which means at least 150 minutes per week of moderate intensity activity or 75 minutes per week of vigorous intensity activity (U.S. Department of Health and Human Services, 2008). The guidelines indicate that physical activity can play a role in preventing a number of negative health outcomes, and the recommendations and benefits are the same for people with and without I/DD.

However, in individuals with I/DD, decreased physical activity and inactivity are far more common than in the general population (e.g., Barnes et al., 2013; Blick et al., 2015; Bodde et al., 2012b; Borremans et al., 2010; Finlayson et al., 2011; Havercamp et al., 2004; Peterson et al., 2008; Stanish & Draheim, 2005). This group is also at risk for cardiovascular disease and musculoskeletal health conditions (Hilgenkamp et al., 2012).

Reinforcement in Health, Fitness, and Physical Activity

Reinforcement in general can be defined as the "process in which a behavior is strengthened by the immediate consequence" that follows it (Miltenberger, 1997, p. 62). When a behavior is reinforced, that means it is more likely to happen again, and it can be positive, negative, or neutral.

One specific type of reinforcement that is often used in the education of individuals with I/DD is social reinforcement. This type of reinforcement has been shown to be capable of facilitating skill acquisition, maintenance, and generalization (Wolery, Bailey, & Sugai, 1998). Social consequences become conditioned reinforcers when they are paired with an unconditioned reinforcer. At that point, the social consequences become reinforcing, and after time, they maintain their value. Examples of social reinforcement are praise, attention, physical contact, and facial expressions.

Research on reinforcement specifically as it pertains to health and fitness is limited at this time. Researchers often use principles of reinforcement in their interventions, but generally have not defined the interventions as such, nor has reinforcement been a component of the research question, at least in adult populations. Researchers in at least two studies analyzed and compared sedentary and active lifestyles, and investigated what was reinforcing about a sedentary lifestyle (Buckworth & Nigg, 2005; Salmon, Owen, Crawford, Bauman, & Sallis, 2003). Buckworth and Nigg (2004) discussed the need for physical activity interventions that were more rewarding than sedentary activities such as using the computer or watching television. Salmon et al. (2003) found that individuals for whom sedentary behavior is rewarding are more likely to be overweight, and that this can and should be incorporated into interventions targeting such behaviors. One review discussed the need for more research in this area, specifically on individual differences in the reinforcing value of either sedentary behavior or physical activity (Epstein, 1998).

Most studies on interventions for increasing physical activity and health behaviors included some sort of reinforcement component. However, the reinforcement was not the primary aspect of the intervention and was usually discussed as an afterthought. Croce and Horvat (1992) incorporated a reinforcement system as part of an overall fitness intervention for adults with I/DD. The system included verbal reinforcement during and after each exercise session and social reinforcement after sessions as part of a greater system for which tokens were rewarded if the individual met the criterion for time spent exercising. They concluded that the system was effective and could be used to increase exercise behavior in individuals with and without I/DD. In another study, researchers compared two types of interventions to increase activity and fitness levels (Dunn et al., 1999). Both interventions included verbal and social reinforcement, however, no greater detail was provided about the specific ways in which reinforcers were implemented. Both interventions led to significant improvements in participants' fitness levels.

One area of need within this line of research is for interventions that enable participants to access naturally occurring reinforcement that would allow the participant to be reinforced for the given behavior independently, without needing an adult or teacher there to prompt and provide reinforcement. These types of interventions could take place in a natural setting as part of a regular fitness program. Consolvo et al. (2004) discussed the importance of public commitment to goals so as to enhance individuals' level of commitment and discussed the need for future work to explore this, and Munson and Consolvo (2012) discussed the use of in-app rewards as reinforcement to participants.

Technology for Physical Activity

Different types of modern technology have been used to allow individuals to self-monitor physical activity levels. One of the most common forms of this type of technology is an accelerometer-based activity monitor, which provides real-time estimates of different aspects of physical activity – frequency, duration, and intensity (Trost, McIver, & Pate, 2005). Accelerometers use a motion sensor to measure the acceleration of the trunk and limbs. As acceleration is related proportionally to energy expenditure, an individual's movement, steps, and energy expenditure can be tracked. They are generally more accurate than traditional pedometers, which can only measure footfalls (walking or running) (Physical Activity Resource Center for Public Health, 2015a, b).

Accelerometers fit into the greater category of wearable devices, which track activity level via sensor while the individual wears the device either on the wrist, clipped to an item of clothing, as an arm band, or in a pocket. Most of these types of devices can also be considered "persuasive technology," as they self-monitor for the purpose of "persuading" the individual to engage in additional activity (Fritz et al., 2014). Examples of wearable, persuasive technology include UbiFit, Chick Clique, Nike+ Fuel Band, Jawbone UP, Striiv, and Bodybugg.

One popular brand of wearable device is the Fitbit, which uses a triaxial accelerometer to measure activity level, specifically, steps (Fitbit Help, 2015). Triaxial accelerometers measure acceleration in three planes: vertical, horizontal, and medial; uniaxial accelerometers measure acceleration in a single plane, usually vertical (Freedson & Miller, 2000). Fitbits have a corresponding app that is accessible via smartphone, tablet, or computer, where users can track their steps taken per day, active minutes, miles walked, calories burned, and sleep patterns. The device is worn on the wrist as a bracelet, and use of the app is simple and relatively intuitive.

Purpose of Experiment 2

The purpose of this study was to examine the effects of app-based social reinforcement on the physical activity levels of college students with I/DD. Specific research questions included:

1. What are the effects of app-based social reinforcement on the physical activity levels of college students with I/DD?
2. Do college students with I/DD find value in incorporating public encouragement challenges into the use of a Fitbit device?

Method

Participants

Four college-aged students ages 19-22 with intellectual/developmental disabilities, namely, intellectual disability and/or autism spectrum disorder, participated in this study. All four students were enrolled in a post-secondary education (PSE) program at a large university in the southeastern United States. Students in this program took program-specific courses in career planning, life skills, and digital literacy while they audited general college courses. Pseudo names were used in order to maintain confidentiality. Student selection in the study was based on an identified desire to become more physically fit or active or on the potential to improve upon their current physical activity level. Further, students were selected who, based on researcher observation and previous baseline data, averaged similar physical activity levels and numbers of daily steps per day. Students were familiar with mobile and tablet apps and took a course called Digital Literacy as a part of the PSE program. Specific student characteristics are included in Table 3 below.

Table 3.
Participant descriptions, Study 2.

Participant	Age	Disability	IQ	Woodcock Johnson IV (Standard Scores / Percentile)		
				Cognitive Processing Speed	Basic Reading Skills	Passage Comprehension
Archie	21	Autism; Intellectual Disability; Orthopedic Impairment	53	<40 / <01	86 / 17	83 / 13
Cameron	20	Intellectual Disability; Orthopedic Impairment	N/A	68 / 2	97 / 43	66 / 1
Carter	19	Autism	70	71 / 3	90 / 26	66 / 1
Elisa	22	Intellectual Disability	49	<40 / <0.1	88 / 21	53 / <0.1
James	21	Autism	80	66 / 1	88 / 21	87 / 19
Joshua	19	Autism	N/A	83 / 13	95 / 36	74 / 4

Archie. Archie was a 20-year-old male student with autism, global developmental delays and an orthopedic impairment. Archie also participated in Study 1. He scored a 53 IQ on the WAIS-IV, placing him in the 0.1st percentile. He demonstrated a relative strength in verbal comprehension, with a 72 composite score (3rd percentile). He scored in the 10th percentile in broad reading ("limited" range) but in the less than 0.1 percentile ("negligible" range) in broad math, math calculation skills, and academic applications.

His scores on the Woodcock-Johnson IV (WJ-IV) demonstrated that he displays very low cognitive processing speed (SS < 40, 0.1st percentile) and low reading skills (SS=86, 17th percentile) and reading comprehension skills (SS=83, 13th percentile). His vocabulary skills are at a 3rd grade equivalent (SS=66, 1st percentile).

Archie was relatively inactive prior to the beginning of the studies here. He did not exercise on a regular basis nor did he spend much time walking around campus. He played on a basketball league which played games about once per week during the season, but that was the extent of his physical activity.

Cameron. Cameron was a 20-year-old student diagnosed with an intellectual disability and cerebral palsy. Results from the WJ-IV indicated low cognitive processing speed when compared to his peers (SS=68, 2nd percentile). He scored within the average range in some areas of reading (e.g., letter-word identification, basic reading skills, word attack, oral reading, and spelling), but scored very low in passage comprehension (SS=66, 1st percentile) and reading vocabulary (SS=54, 0.1 percentile).

Cameron wore a Fitbit prior to the start of this study, as he had received his own as a gift a year prior. However, he did not achieve the recommended 10,000 daily steps on a regular basis, nor did he actively participate in regular physical activity. Cameron requested to join the study and indicated that he had a strong desire to take more steps.

Carter. Carter was a 19-year-old male student with autism who also participated in Study 1. He scored a standard score of 70 on the Reynolds Intellectual Assessment Scale. Results from the WJ-IV indicate low cognitive processing speed when compared to peers of his age (SS=71, 3rd percentile), low average basic reading skills (SS=90, 26th percentile), and low passage comprehension skills (SS=66, 1st percentile). Prior to the study, Carter did not participate in regular physical activity or exercise. However, Carter did walk on campus often, as his classes tended to be further away from the PSE program offices than other students.

Elisa. Elisa was a 22-year-old female student diagnosed with an intellectual disability and hearing impairment who was also a participant in Study 1. Her full-scale IQ was a 49, placing her in the less than 0.1 percentile. She also demonstrated "extremely low" adaptive behavior capabilities in a number of areas at both home and school, with a relative strength in social skills (50th percentile at home, 3rd percentile at school). Her WJ-IV results indicate that she has a very low cognitive processing speed (SS < 40, <0.1 percentile), very low passage comprehension skills (SS=53, <0.1 percentile), and low average basic reading sills (SS=88, 21st percentile).

Elisa also used her own Fitbit during this study. She received it as a gift immediately following Study 1. Elisa has a fairly active family, with many immediate and extended family members who regularly attend group fitness classes and go walking and hiking. Elisa enjoys activities like these, however, did not regularly achieve the recommended number of steps per day prior to the start of the study.

James. James was a 21-year-old male student with autism. On a recent intelligence test (Wechsler Adult Intelligence Scale – Fourth Edition), James achieved a standard score of 80, placing him in the "borderline" range and in the 9th percentile. On the WJ-IV, James demonstrated strengths in oral reading (SS=100, 49th percentile) and in letter-word identification (SS=93, 33rd percentile). His weakest areas were in word attack (SS=82, 12th percentile) and in passage comprehension (SS=87, 19th percentile). On an adaptive behavior scale (Vineland Adaptive Behavior Scales), James scored a 49, placing in in the <0.1st percentile.

Prior to this study, James tended to be inactive throughout the school day and on weekends. He was very interested in card games and in his iPad. He had also gained some weight during his first year of college due to inactivity. After seeing fellow students in the program using Fitbits during Study 1, James asked for his own Fitbit, which he received as a gift. He used his own Fitbit for this study.

Joshua. Joshua was a 19-year-old student diagnosed with autism. On a recent administration of the WJ-IV, Joshua demonstrated relative strengths in word attack (SS=100, 51st percentile), oral reading (SS=96, 39th percentile), and basic reading skills 9SS=95, 36th percentile). His weakest areas were passage comprehension (SS=74, 4th percentile), overall reading (SS=82, 12th percentile), and reading vocabulary (SS=84, 14th percentile).

He enjoyed playing basketball and boxing, and had lost some weight during the year prior to this study when he started exercising. Joshua expressed great interest in the study, and even requested to wear a Fitbit and to participate.

Setting

The second experiment was conducted on the campus of a large public university in the southeastern United States. Student participants attended a postsecondary education program

(PSE) that was specialized for students with I/DD. Each student enrolled in traditional college coursework for audit credit while also participating in a work-based internship and program specific-courses including life skills, career and life planning, and digital literacy.

All phases of the study took place on campus. However, since students wore Fitbit devices throughout the day, including after school hours, data collection occurred both on and off campus.

Materials

The Fitbit Blaze was also used in the second experiment. This type of wearable device is worn on the wrist and automatically tracks activity level via a triaxial accelerometer (Fitbit Help, 2015). A triaxial accelerometer measures acceleration in three planes: vertical, horizontal, and medial. For this reason, this device was selected over other similar devices that utilize a uniaxial accelerometer, which measure acceleration in only one plane, usually vertical (Freedson & Miller, 2000). The Fitbit Blaze can also track number of steps, distance, calories burned, active minutes, and sleep patterns. The participating PSE program and students had access to a set of Fitbit Blazes.

The associated Fitbit app also was incorporated into this experiment so that participants could actively and independently monitor their own individual activity levels. This app was installed on each student's individual device (school-provided iPad, personal smartphone, personal tablet, or all three) and synced with each individual participant's assigned Fitbit. Students with compatible personal devices were able, but not required, to install the app on that device as well. The Fitbit app and dashboard allows users to view the total number of steps taken per day, the total distance, total calories burned, total floors climbed, and total number of active minutes. Users can also manually enter exercise that is not recognized by the Fitbit step count, log and track their weight, view sleep patterns, and track calories eaten and daily water intake.

The Fitbit app also awards "badges" to users who earn them by achieving certain goals. There are badges for certain number of steps in a day, total lifetime steps, total lifetime miles, total floors climbed in a day, etc. The app automatically awards the badges once the user achieves each particular goal.

Goal setting is also incorporated into the Fitbit app. Users are able to set their own goals for varying factors (activity levels, exercise, water intake, calorie intake, time asleep) and can then see progress towards their goals via visual representation within the app (i.e., graphs). The dashboard within the app shows the percentage of the daily step count goal that the user has reached. Figure 8 below shows the Fitbit dashboard with goals achieved for all available factors (achievement of the daily goal is represented by green; if the goal was not yet achieved, the circles would be blue).

Within the Fitbit app, users can add "friends" who also use a Fitbit and have downloaded the app. The app shows the user's friends ranked in order of number of steps taken over the course of the past 7 days. Users can send messages to friends, "cheer" their friends, and "taunt" their friends. Figure 9 below shows a friend's profile including "cheer", "taunt", and message options, as well as badges and trophies earned. Figure 10 below shows a friend list within the dashboard.

The Fitbit app also enables users to participate in "challenges" with other users to allow for interaction and friendly competition. To set up a challenge, users can click on the "challenges" tab of the app, select a challenge, and invite other users (up to 10 total participants). The app then automatically keeps all participants in the challenge updated on individual progress

Figure 8. Fitbit dashboard showing green, filled circle representing that the daily step count, floors climbed, distance, calories and active minutes goals were achieved.

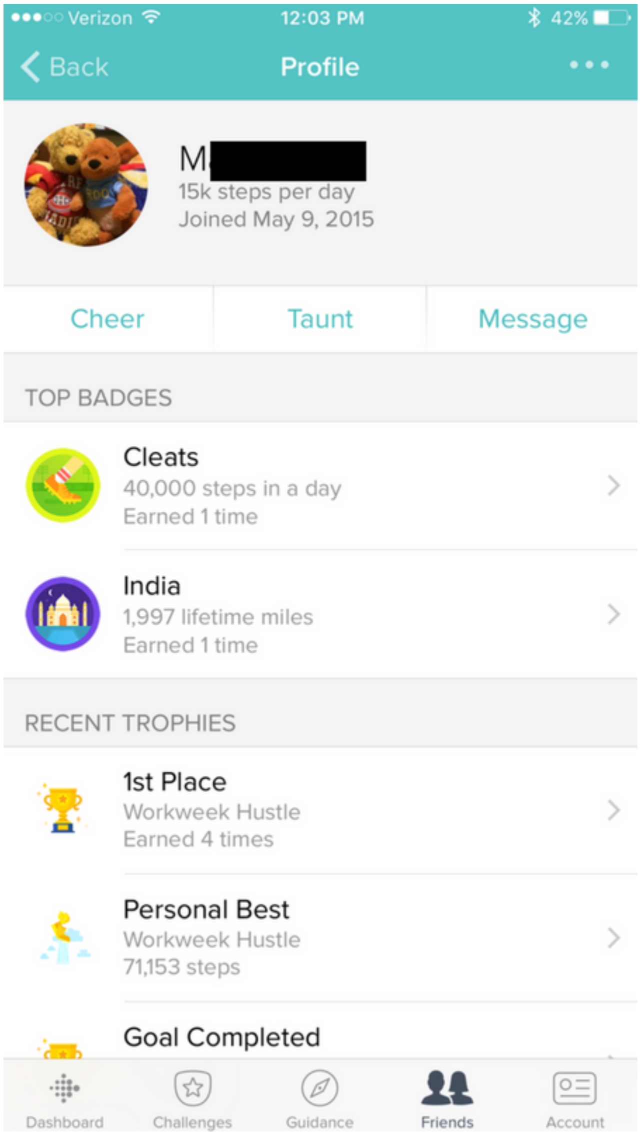

Figure 9. Sample profile of a Fitbit "friend," where users have options to cheer, taunt, or message the user, as well as the friend's badges and recent trophies.

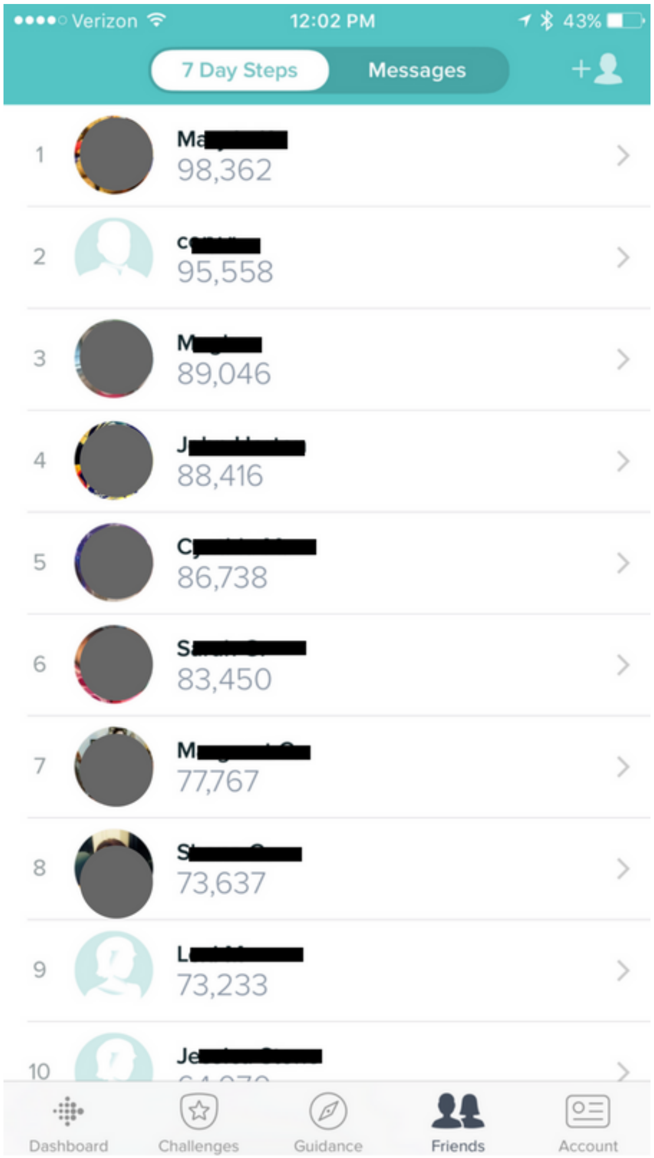

Figure 10. Sample "friend list" from the Fitbit app, showing total 7-day step count for all friends ranked in order of number of steps taken.

as well as the progress of other participants via notifications and an ongoing log. The ongoing log includes activity by all participants within the challenge: when a user achieves his or her step goal, when a user surpasses another in total steps, when two users are in close competition, etc The log also allows each user to send a message that is viewable within the log to all members of the challenge. Figure 11 shows a sample ongoing log for a sample Workweek Hustle challenge.

There are four possible challenges on the Fitbit app: the "Goal Day" challenge, which encourages users to reach their daily goal, the "Workweek Hustle" challenge, where users aim to get the most steps between Monday and Friday, the "Weekend Warrior" challenge, where users aim to take the most steps on the weekend, and the "Daily Showdown," which determines which user takes the most steps in 24 hours. This particular study incorporated the "Workweek Hustle" challenge.

Other required materials included individual Fitbit chargers, which stayed on campus in the lead researcher's office, located in the PSE program's headquarters, so that Fitbit devices could be charged during the weekend. Students turned in their Fitbits at the end of the day on Friday and Fitbits were distributed on Monday morning when students arrived on campus.

Variables and Data Collection

The dependent variable was the number of steps taken daily, Monday through Friday, as measured by each individual student's assigned Fitbit. All participants had class together first thing on Monday morning, at which time the Fitbits were distributed to all participants. Measured steps were viewed on the Fitbit app on each participant's iPad and on www.fitbit.com and then transferred weekly to a data collection form in a spreadsheet accessible only to the lead researcher.

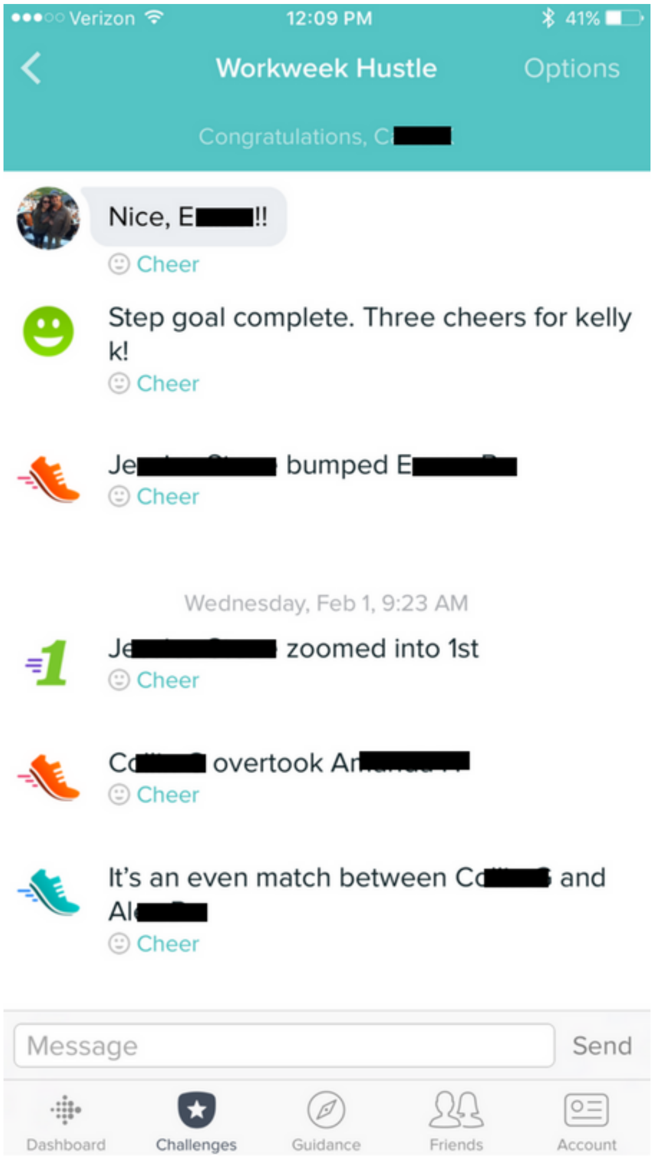

Figure 11. Sample ongoing log from Workweek Hustle challenge on the Fitbit app.

The independent variable was the implementation of app-based social reinforcement. The lead researcher initiated the challenge by "challenging" students who were participating in the study as well as participants' "best buddies" and friends who desired to participate, up to 10 total participants. The lead researcher selected the app-based "Workweek Hustle" challenge.

The login at www.fitbit.com was used to collect data. Users can log into the website and view their daily steps, weekly steps, monthly steps, and even yearly steps. Users can then download printer-friendly bar graphs for visual comparison. The site also allows users to create bar graphs for specific dates.

At the end of baseline and intervention phases, each participant's total number of steps taken throughout baseline and intervention weeks was graphed for visual analyses.

Procedures

Baseline. During baseline phase, each participant wore a Fitbit for 5 consecutive days. Data were collected for a minimum of five days or until stability was observed. Stability was determined using Gast's (2010) "80%-20%" criteria, where data are considered to be stable when 80% of the data points fall on or within 20% of the median baseline value. Students were able to view the Fitbit app and corresponding data on their own individual devices if they desired.

Training in Fitbit app. Three of the participants in this study had been comprehensively trained in the use of the Fitbit and the corresponding app as a part of Experiment 1 (Archie, Carter, and Elisa). If they did not wear a Fitbit during the semester prior, however, participants were trained in the use of the Fitbit and the corresponding app. They were also asked if they would like to install the app on their own personal smartphone or tablet, and assistance was provided if needed.

The lead researcher provided instruction to individual participants on each aspect of the

Fitbit app. Prior to this instruction, students had participated in lessons on calories burned, activity levels, the importance of physical activity, and ways to increase fitness levels during the Life Skills course that was taken as part of the PSE program. The lead researcher first reviewed the data from her own Fitbit app, explaining how to find and interpret number of steps taken, whether the battery was low and needed to be charged, how many miles walked each day, how many calories burned, number of active minutes, and sleep patterns. For purpose of this experiment, the categories of sleep patterns, calories eaten, and water intake were not considered.

Individual students were then able to review their own Fitbit app and were provided assistance in finding and interpreting number of steps taken, whether the battery was low and needed to be charged, how many miles walked each day, how many calories burned, and number of active minutes. Students practiced using the Fitbit and the app until they were able to access the app, sync the app with their Fitbit, and find their step counts independently.

Intervention: app-based social reinforcement. The intervention was implemented after one week of wearing the Fitbit without any reinforcement. On the first Monday after baseline phase, the lead researcher initiated the "Workweek Hustle" challenge on the Fitbit app and "challenged" all participants to the challenge. The lead researcher set preferences on the Fitbit app so that students would receive reminders and notifications pertaining to their progress in the challenge as well as the progress of their fellow participants.

Experimental Design

A withdrawal/reversal (ABAB) design (Gast & Hammond, 2010) was employed in order to determine whether a causal relationship existed between the implementation of app-based social reinforcement and the number of steps taken per day (Horner et al., 2005). This type of design demonstrates experimental control when the target behavior (here, steps taken per day) improves during the intervention phases (B_1 and B_2) and deteriorates during baseline phases (A_1 and A_2) (Gast & Hammond, 2010).

The study began with at least five days of data during the baseline phase for all students. Baseline (A_1) stability was established as a minimum of 80% of the data points falling on or within 20% of the median baseline value (Gast, 2010). Once this was established, the app-based social reinforcement intervention (B_1) was then implemented so that all students participated simultaneously. The intervention incorporated the "Workweek Hustle" challenge within the Fitbit app. This challenge took place over the course of five consecutive week days; thus, intervention phases occurred for one school week (5 days). At the end of the "Workweek Hustle" challenge (so, after 5 consecutive week days), students returned to baseline conditions (A_2) and continued to wear the Fitbits without participating in a challenge. After another week of baseline, another Workweek Hustle challenge was initiated among participants. This took place for four total consecutive weeks.

Peer mentors from the "Best Buddies" program on campus also participated in the intervention. During individual meetings and phone calls, the lead researcher provided the mentors with a brief overview of the study, its goals, and its procedures, and asked them if they would like to participate. Mentors who agreed were then paired with a participant (when possible, they were paired with their already-established "best buddy").

The lead researcher then sent a group email to all mentors who agreed to participate. The email included details of the study, what their participation requirements were, and details for distribution of the Fitbits (if mentors did not already have their own personal Fitbit, they were able to use one of the university's Fitbits). When mentors came to the lead researcher's office to pick up their assigned Fitbit, the lead researcher did a brief training on the device and the associated app; they reviewed how to friend request other users, how to accept challenges, how to send messages, cheers, and taunts to other users within the app, and how to charge their Fitbit. Mentors were required to interact at least one time per day with their assigned participant; this could be in the form of a cheer, taunt, message, or note within the challenge.

Data Analysis Procedures

Visual analysis procedures were utilized in order to evaluate the effect of the intervention on each individual's total number of steps taken daily. Six indicators were used to examine data patterns and assess intervention effects: (a) level, (b) trend, (c) variability, (d) immediacy of the effect, (e) overlap, and (f) consistency of data patterns across similar phases (What Works Clearinghouse, 2014). Within-phase comparisons were evaluated to assess predictable patterns of data. Data from adjacent phases were used to assess whether manipulation of the independent variable was actually associated with a change in the dependent variable. Finally, data from all phases were examined to determine whether a functional relation was present (Gast 2010).

Other, statistical measures can corroborate visual analysis results, providing greater confidence and a quantifiable analysis, showing the magnitude of the effect (Campbell & Herzinger, 2010). A common analysis calculated during single-case methodology is effect size to determine the efficacy or effectiveness of the study. The most common calculation of effect size is percentage of non-overlapping data (PND), which calculates percentage of data that does not overlap between the baseline and following intervention phases (Scruggs et al., 1987). It is easy to calculate, in alignment with the tradition of visual analysis in single case design, and demonstrates intuitive appeal (Campbell & Herzinger, 2010, p. 442). Scruggs and Mastropieri (2001) crafted interpretational guidelines for PND, specifically, that PND greater than 90% is a highly effective intervention, PND greater than 70% but less than 90% is an effective intervention, PND greater than 50% but less than 70% is a questionably effective intervention, and PND less than 50% demonstrates unreliable effectiveness for interventions. In this experiment, the percentage of non-overlapping data (PND) was calculated for each participant between the baseline and intervention phases.

Interobserver Agreement (IOA) and Procedural Reliability

The lead researcher, a doctoral student in special education, trained a research assistant, an undergraduate student, to collect interobserver agreement (IOA) and procedural reliability data.

IOA data were collected during a minimum of 20% of baseline and intervention conditions for each individual participant. A research assistant was trained in the study's data collection procedures. Both the lead researcher and research assistant reviewed each participant's number of steps taken at the end of each week when data was transferred to the data collection spreadsheet. The percentage of IOA was calculated for each participant by adding the number of agreements between observers (agreement on the outcome variable) and divided by the total number of agreements and disagreements combined, then multiplying by 100%. If IOA fell below 90%, the two observers would have reviewed all daily step counts together. The percentage of IOA was 100%.

Procedural reliability data were collected at the start of each week of baseline or intervention phase to ensure that the phase was implemented as it was intended. This was assessed by direct observation using a procedural reliability form (Appendix C). The form included a checklist that included each step that was to be taken in starting either baseline or intervention phase. Additionally, a Google Forms survey was administered to all participating peer mentors to ensure that they followed the requirement to send at least one message per day to their assigned participant during intervention weeks (Appendix D).

During baseline and return to baseline weeks, procedural reliability was calculated by dividing the total number of observed activities that took place during the initial setup by the number of planned activities that were to take place during initial setup and multiplying by 100. During intervention weeks, procedural reliability was calculated by dividing the total number of observed activities that took place during the initial setup plus the number of days that peer mentors reported messaging their partner participant divided by the total number of planned activities that were to take place during initial setup plus the number of possible days that peer mentors could have messaged their partner participant and dividing by 100. Procedural reliability was defined as 90% or greater. If it was lower than 90%, the research team met to clarify procedures. The overall mean for procedural reliability was 96.5% (range = 85.7% - 100%). Archie's treatment integrity was 100%; Cameron's treatment integrity ranged from 85.7% to 100% (M = 95.8%); Carter's treatment integrity ranged from 85.7% to 100% (M = 95.8%); Elisa's treatment integrity was 100%; James' treatment integrity ranged from 85.7% to 100% (M = 91.67%); Joshua's treatment integrity ranged from 85.67% to 100% (M = 95.8%).

Social Validity

After intervention phases had been completed, social validity was assessed with a Likert-type survey (see Appendix E). This was created by the lead researcher in order to assess participants' opinions and thoughts on the use of a Fitbit, the use and appropriateness of the app-based challenges, how it helped (or did not help) their activity levels, and whether they felt that they would continue to monitor their activity levels after the study was completed (see Appendix D).

Items were read aloud to the students if needed, and each item ranged from 1 (strongly disagree) to 5 (strongly agree). The questionnaire also included open-ended questions to allow students to give additional information if desired. These answers were scribed by the researcher if needed.

Results

Baseline results indicated that most students generally achieved less than the recommended 10,000 steps per day (Tudor-Locke & Bassett, 2004). Baseline also demonstrated great variability from day to day and from student to student, usually due to inconsistent school schedules. The extent of improvement varied across students; however, visual analysis suggested that social reinforcement and competition delivered via the Fitbit app was an effective way to improve step counts. Results for individual participants are discussed in detail below, as are effect size averages.

Archie. Archie demonstrated improvements throughout the course of the intervention, particularly during the final week (see Figure 12). During baseline, Archie averaged about 4471 steps per day, although this was highly variable and ranged between 777 steps and 7752 steps. During the first intervention phase, Archie increased 6.5% to a 4760 step count average. When the intervention was withdrawn during week three, Archie decreased his step count average to 4545, a decrease of 4.5%. In the fourth and final week, Archie averaged 6398 steps, an increase of almost 41% from his week three average and an increase of 43% from his baseline average of 4471 steps. While his mean improved during B_1 and B_2, it is difficult to determine whether there is a functional relation, as days 1 and 2 were much higher than the others.

Effect size across phases was measured in terms of percentage of non-overlapping data (Scruggs et al., 1987). From baseline (A_1) to the first intervention phase (B_1), Archie's

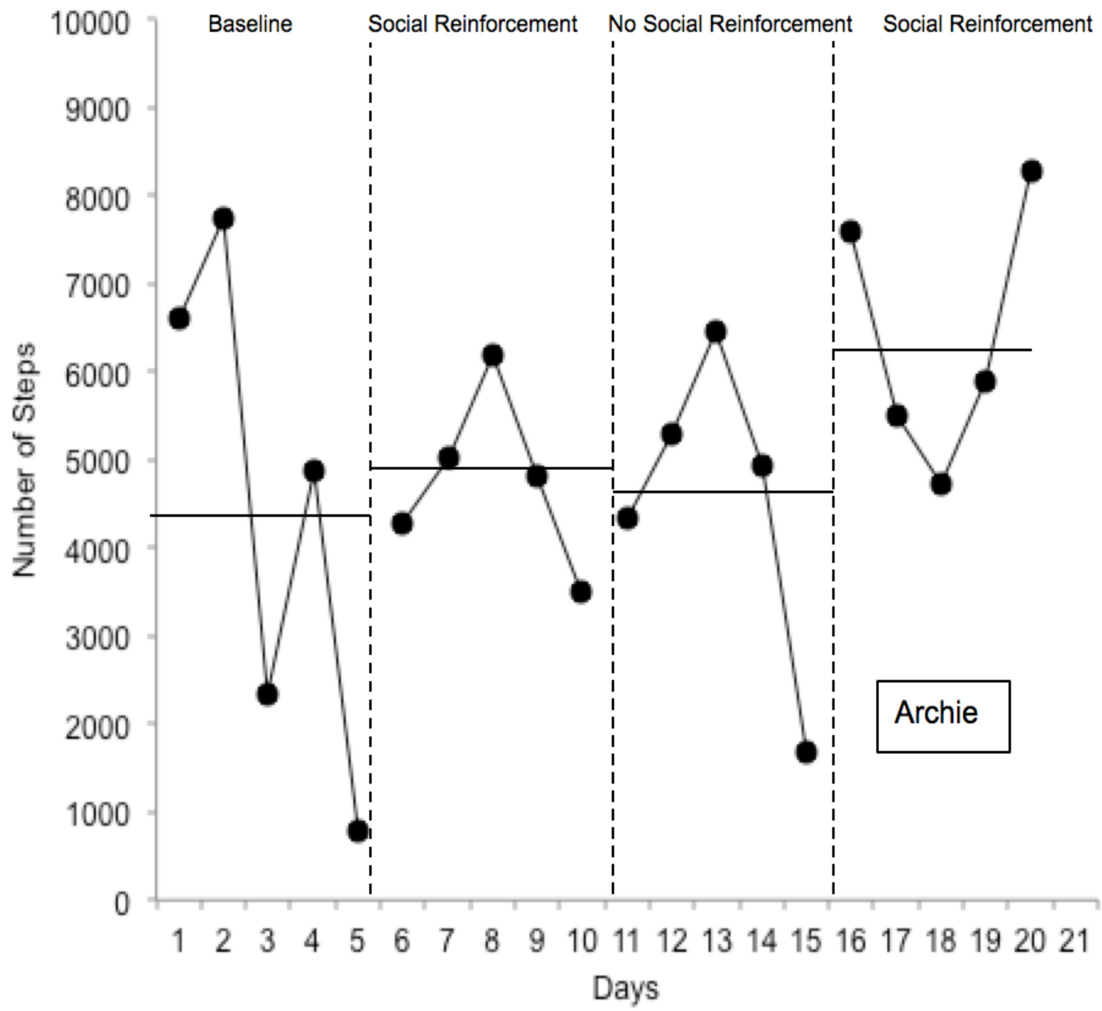

Figure 12. Archie's total number of steps during baseline and intervention phases; horizontal lines indicate mean step count for each phase.

percentage of non-overlapping data was 0%, which indicates unreliable effectiveness (Scruggs & Mastropieri, 2001). However, it should be noted that Archie demonstrated high variation from day to day, and his highest step count in week one of 7752 steps seemed to be somewhat of an outlier. Percentage of non-overlapping data from the second baseline phase (A_2) to the second intervention phase (B_2) was 40%, which also indicates unreliable effectiveness. Again, the great variability from day to day should be considered when interpreting the effect size here.

Cameron. Cameron responded very well to the intervention and was also able to see improvements throughout all phases, particularly from baseline to the end of the second intervention phase (see Figure 13). He averaged 7208 steps in the first baseline phase (A_1). His improvement from the first baseline phase to the first intervention phase (B_1) was slight, with an average of 7254 in B_1, an increase of 0.62%. From the return to baseline phase (A_2) to the second intervention phase (B_2), however, Cameron saw a 41.25% improvement, increasing his average from 7040 steps in A_2 to 9944 steps in B_2.

Effect size calculations indicate unreliable effectiveness from to A_1 to B_1 with 0% non-overlapping data; however, this should be considered cautiously, as Cameron attained an abnormally high step count on day five of A_1. Effect size calculation between A_2 and B_2 indicated a questionably effective intervention with 60% non-overlapping data. Again, due to inconsistency in step counts from day to day, this should be interpreted carefully.

Carter. Carter, who also participated in Study 1, was also able to see improvements in terms of averages between phases (see Figure 14). He averaged 11562 steps in the first baseline phase (A_1) and then increased his average step count by 7.57% in the first week of intervention with an average of 12437 steps. During the return to baseline (A_2), his average step count decreased to 11488 steps on avarege, but then increased again in B_2 to 13915 average steps.

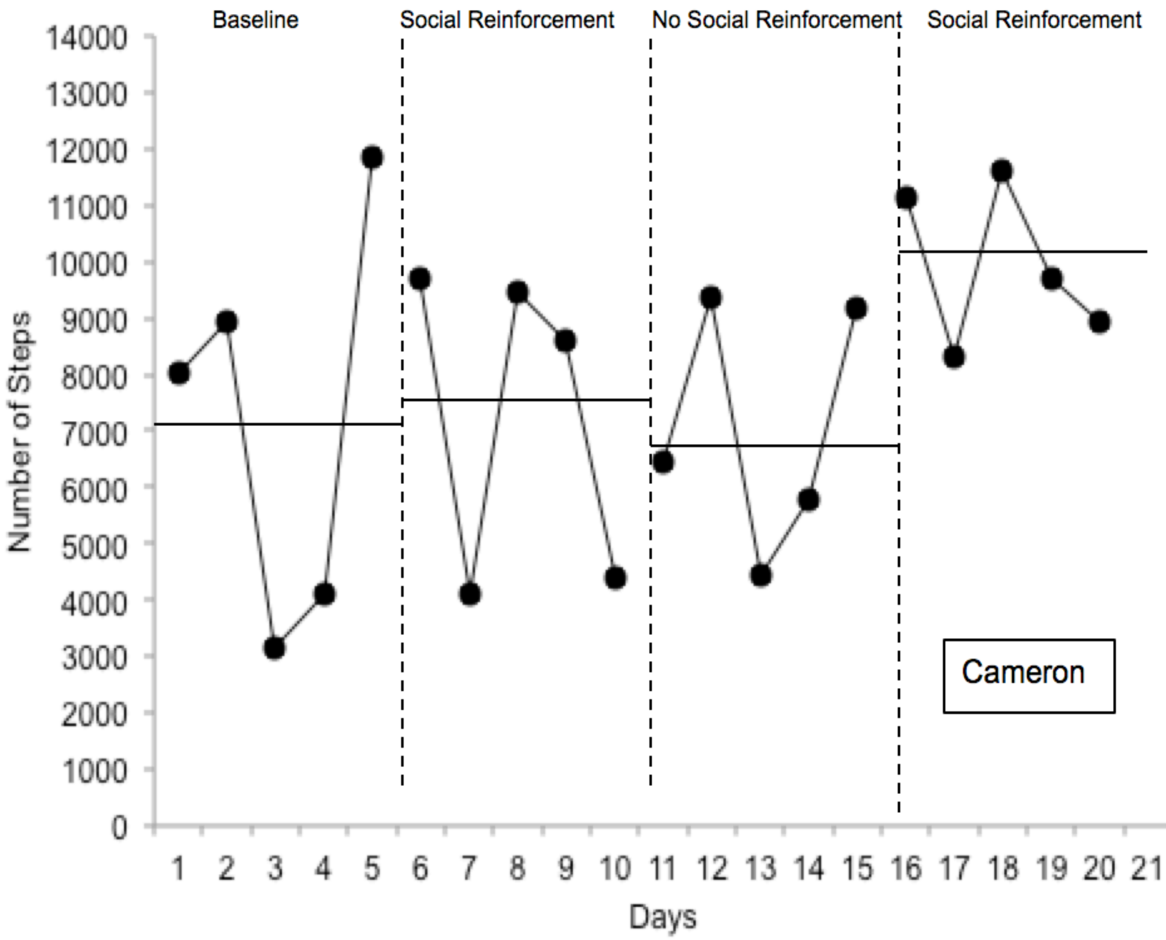

Figure 13. Cameron’s total number of steps during baseline and intervention phases; horizontal lines indicate mean step count for each phase.

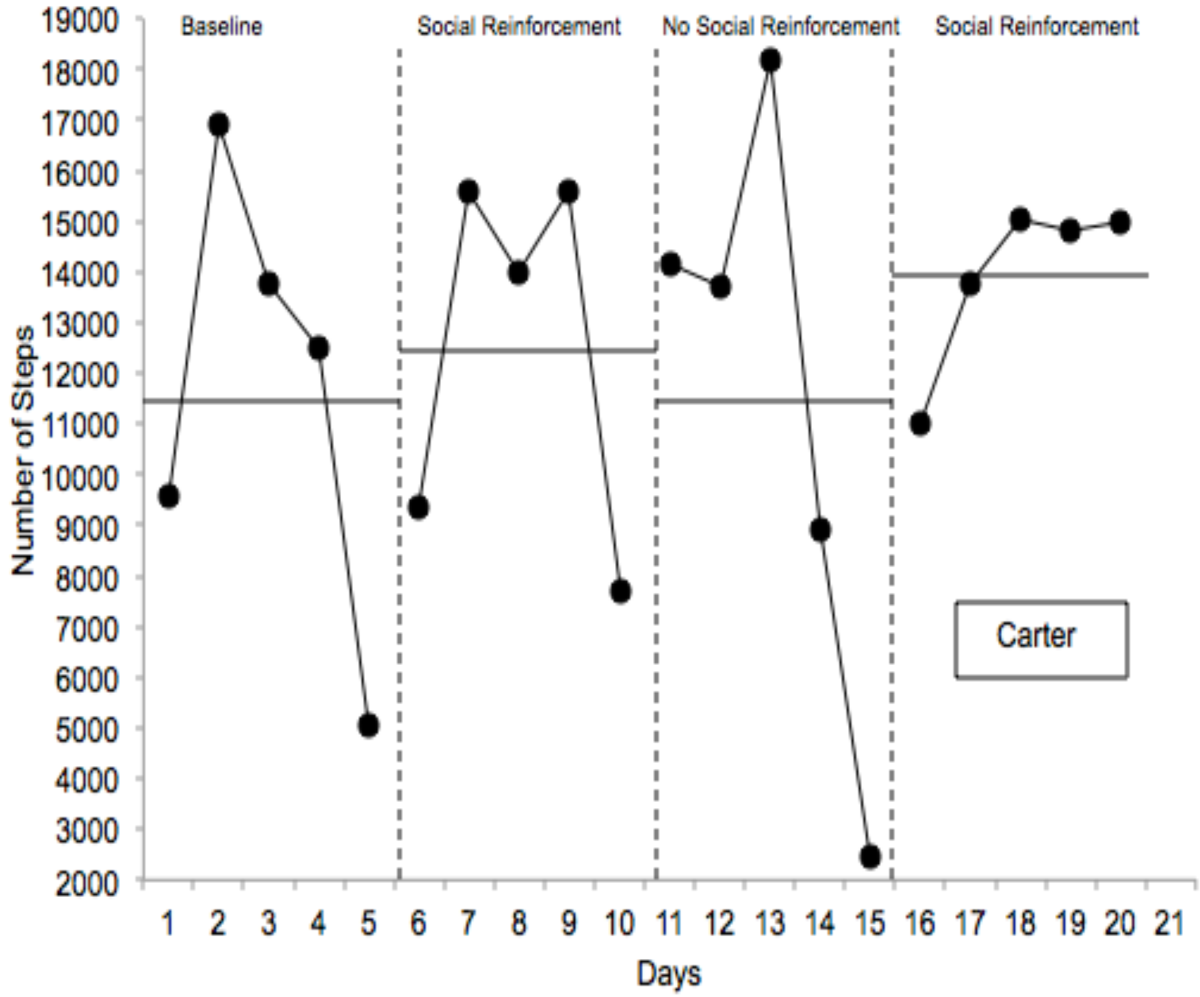

Figure 14. Carter's total number of steps during baseline and intervention phases; horizontal lines indicate mean step count for each phase.

His final week's average of 13915 steps was an increase of 21% from the A_2 phase and a 20.35% increase from the A_1 phase.

While Carter's averages between phases show that Carter responded well to the intervention, the effect size calculations indicate unreliable effectiveness between all phases with 0% non-overlapping data between A_1 and B_1, between A_2 and B_2, and between A_1 and B_2. However, this should be interpreted carefully, as visual analysis also shows that Carter saw much greater consistency during intervention phases, particularly during the final intervention phase (B_2). Further, it should be noted that Carter achieved abnormally high step counts on two different days during baseline weeks.

Elisa. Visual analysis shows significant improvements in both step counts and effect sizes between all phases of this intervention for Elisa (see Figure 15). Her step count average improved from 5389 to 9678 steps between baseline baseline (A_1) and the first intervention week (B_1), an improvement of 79.6%. In the second intervention phase (B_2), Elisa's step count average improved from 6693 steps to 10150 steps, an improvement of 51.64%. She improved an average of 88% from the initial baseline phase (A_1) to the final intervention phase (B_2).

Effect size calculations as measured by percentage of non-overlapping data show that this was, overall, an effective intervention for Elisa. From the initial baseline phase to the first intervention phase (A_1 to B_1), Elisa's percentage of non-overlapping data was 80%, indicating an effective intervention (Scruggs & Mastropieri, 2001). From the second baseline phase to the second intervention phase (A_2 to B_2), her percentage of non-overlapping data was 20%, indicating an unreliably effective intervention. However, most notably, from the initial baseline phase to the second intervention phase (A_1 to B_2), Elisa's percentage of non-overlapping data was 100%, indicating a highly effective intervention.

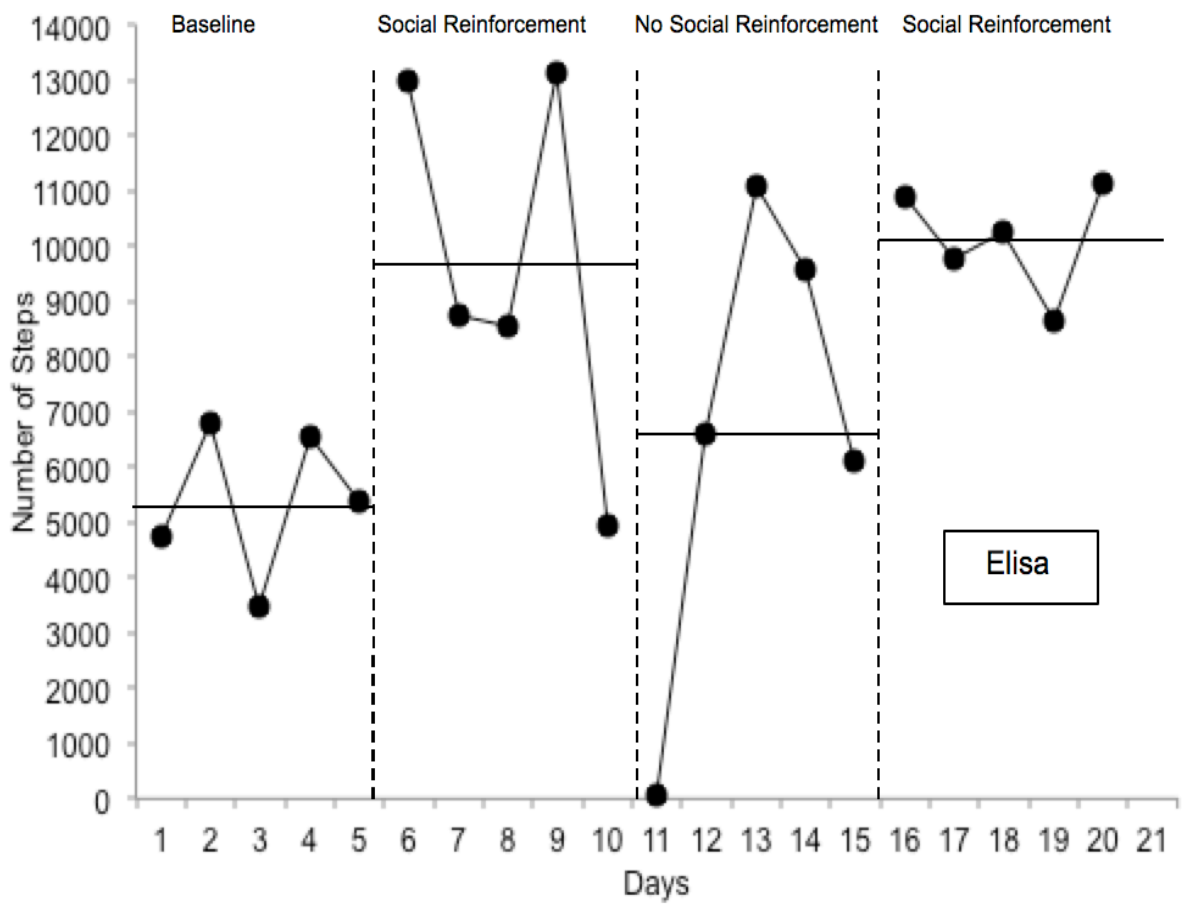

Figure 15. Elisa's total number of steps during baseline and intervention phases; horizontal lines indicate mean step count for each phase.

James. Figure 16 shows James' results across baseline and interventions phases. From the first baseline phase (A_1) to the final intervention phase (B_2), James demonstrated a 10.5% improvement in average step count (11764 average steps in A_1 to 12996 average steps in B_2). During the initial intervention phase (B_1), James improved 6.4% on average. Between the second baseline phase and the second intervention phase, he improved 10.9% on average.

Effect size calculations indicated an unreliably effective intervention for all phases (Scruggs & Mastropieri, 2001). However, this should be interpreted cautiously, as James' averages clearly improved during intervention phases, as did his level of consistency from one phase to the next.

Joshua. Joshua's average step count very clearly improved during intervention phases and very clearly decreased when returned to baseline phase (See Figure 17). Between the initial baseline phase (A_1) and the first intervention phase (B_1), Joshua improved from 13419 average steps to 21775 average steps, an increase of 62.3%. Between the second baseline phase (A_2) and the second intervention phase (B_2), he improved from 12004.6 average steps to 20027.8 average steps, an increase of 66.8%. Overall, between the initial baseline phase (A_1) and the second intervention phase (B_2), Joshua improved from 13419 average steps to 20027.8 average steps, an increase in 49.25% overall.

Like other participants, effect size calculations should be interpreted cautiously, as inconsistency from day to day makes such a calculation a challenge. Effect size was measured in terms of percentage of non-overlapping data (Scruggs & Mastropieri, 2001). Between phases (A_1 to B_1, A_2 to B_2, and A_1 to B_2), the highest percentage of non-overlapping data was 60% between A_2 and B_2, indicating questionable effectiveness. The other two phases had 0% and 20% non-overlapping data, respectively, indicating unreliable effectiveness.

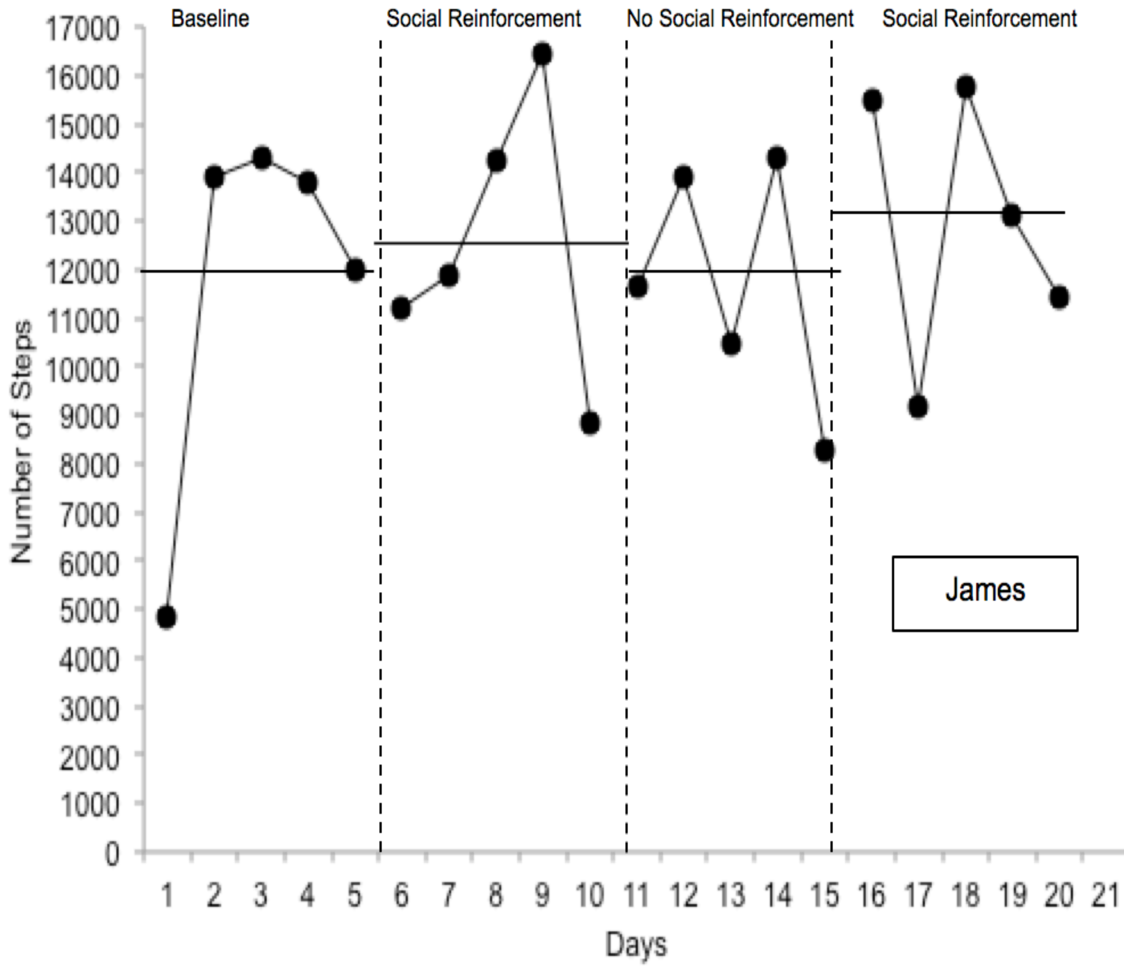

Figure 16. James' total number of steps during baseline and intervention phases; horizontal lines indicate mean step count for each phase.

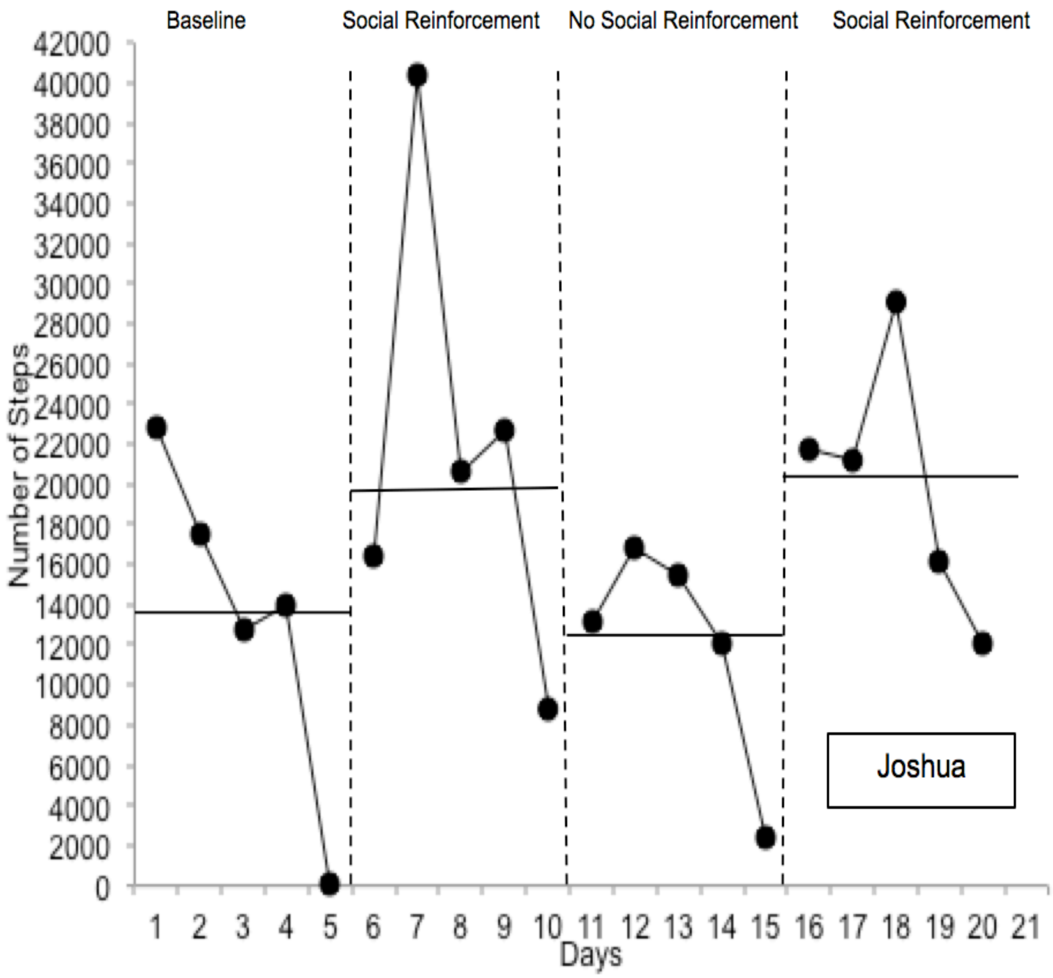

Figure 17. Joshua's total number of steps during baseline and intervention phases; horizontal lines indicate mean step count for each phase.

Social Validity Results

After the study was completed, all participants completed a questionnaire in which they were asked their thoughts on the Fitbit, the app-based challenges, and physical activity in general. The questionnaire consisted of 14 questions that incorporated a 5-point Likert-type scale as well as 3 open-ended questions (See Appendix E).

Overall, students reported positive opinions on the app-based challenges and on the use of the Fitbit in general. All participants strongly agreed that (a) using the Fitbit was helpful in tracking activity levels, (b) they wanted to continue using a Fitbit, and (c) they enjoyed the social aspect of the challenges. All students either agreed or strongly agreed that (a) they liked using a Fitbit to track activity level, (c) they liked wearing it daily, (c) the challenges were fun, (d) they wanted to continue to be more physically active, and (e) they felt capable of determining how to get more physical activity each day. The only items on the questionnaire for which not all of the students generally responded positively was that challenges could help in other areas of life as well (Elisa and Cameron responded neutral to this one), that they enjoyed seeing their friends' number of steps (Cameron responded neutral), and that remaining connected with friends during the challenges played a big role in helping to increase activity level (Elisa slightly disagreed with this one).

The open-ended questions on the questionnaire indicated that participants enjoyed the challenge, that they found the Fitbits to be an acceptable wearable device, and that they wanted to continue wearing it. Table 4 below includes specific responses.

Table 4.

Individual participant responses to social validity questionnaire, Study 2.

Student	Questions		
	Open-ended Question 1: What did you like or not like about the Fitbit and the Fitbit app?	Open-ended Question 2: What was it like to use the Fitbit and the Fitbit app?	Open-ended Question 3: Any other thoughts about the Fitbit, the challenges, or physical activity?
Archie	"The Fitbit app is very easy. It makes it easier to get more steps."	"It was really easy for me."	"I think the challenges are really, really easy.
Cameron	"I like it because it can tell me my steps and how active I'm getting. I kind of like everything."	"Always easy."	"The more you wear it, the more you can keep track of how active you are every day. Some people got ahead of me, some people didn't get ahead of me."
Carter	"I like it because I get more steps than I needed."	"I use it every week."	"No.
Elisa	"I like using my Fitbit. It's great getting my steps in. I've been doing Just Dance at home – it helps me get more steps. I like being wild!"	"It is easy to use."	"I'm doing a challenge now with my mom and her friends."
James	"I like the step counts."	"It is awesome."	"No."
Joshua	"I love everything about it."	"It encourages me to be active and knowing what I do for workouts."	"It was fun!"

Discussion

The purpose of this study was to examine the effects of social reinforcement provided within the Fitbit app on the physical activity levels of college students with I/DD by determining whether the reinforcement was effective in increasing physical activity levels and whether the students found value in the reinforcement. All participants improved their average step counts during intervention phases, thus improving their overall physical activity levels. While average step counts improved, it was difficult to find a true functional relation for most participants.

In addition to the results from visual analysis and the social validity questionnaire, the researcher found that students seemed to truly enjoy wearing Fitbits, tracking their step counts, and interacting with their peers and each other on the Fitbit app. During the baseline phase of this study, students were ready to start challenging each other. In fact, several participants tried to start their own challenges within the Fitbit app, during baseline and intervention phases. Participants asked for rewards for "winning" the Workweek Hustle challenges; some asked for Starbucks cards, others asked for cash. They also were able to explore the Fitbit app on their own and find other friends and family members outside of the study participants. During intervention phases, some participants (in particular, Joshua, James, and Cameron) paced the halls near the program office, went on long walks around campus during their down time, and took more group fitness classes on and off campus.

Research that successfully incorporates social reinforcement as a primary component of an intervention to improve physical activity for individuals with I/DD is limited, however, the findings here support previous research in several ways. First, as an intervention that utilizes wearable technology to track activity levels, this study continues a line of previous research from studies that tracked activity levels for individuals with I/DD with accelerometers and/or pedometers (e.g., Bodde et al., 2013; Frey et al., 2005; Phillips & Holland, 2011; Stanish 2004; Stanish & Draheim, 2005; Stanish & Draheim, 2007; Temple et al., 2000; Temple & Walkley, 2003).

This study also supports one identified "best practice," which indicates that community-based activities where peer mentors are involved and inclusion is valued is an effective way to improve physical activity levels of adults with I/DD (e.g., Bazzano et al., 2009; Lotan et al., 2006; Marks et al., 2013; Stanish & Frey, 2008). Stanish and Frey (2008) also indicated that one strategy is to provide fun activities that involve the use of social skills. By involving known peer mentors, implementing the intervention within an inclusive community (the challenge "group" within the Fitbit app which consisted of individuals with and without disabilities), and facilitating social skills, the intervention in this study successfully supports this best practice.

The results from this study extend the current base of research in several ways. Primarily, it extends it in that there is limited research in the area of health, fitness, and physical activity for adults with I/DD at this time (e.g., Rimmer, 1999; Spanos et al., 2013; Stanish & Frey, 2008; Temple et al., 2006). There is little to no research that explores the use of wearable technology in order to improve physical activity levels in this population. By exploring the use of wearable technologies to improve activity levels of individuals with I/DD, this study extends the research base and indicates that wearable technology is an appropriate, effective strategy to improve physical activity levels via increased daily step counts.

These results also extend the small body of research that suggests that social reinforcement could be an effective strategy to increase physical activity in adults with I/DD. Previous studies have incorporated social reinforcement into interventions which aimed to increase physical activity levels, however, the reinforcement was not the primary component of the intervention. A study from Croce and Horvat (1992) incorporated verbal and social reinforcement into a greater token system that successfully improved exercise behaviors in individuals with I/DD, and a study by Dunn et al. (1999) also included verbal and social reinforcement to improve participants' fitness levels. However, in neither of these studies was the reinforcement the primary component of the intervention. Therefore, the research presented in this study extends this line of research to demonstrate that an intervention whose primary component is social reinforcement can be an effective way to improve physical activity levels within this population.

Another way that this study extends the current research base is by facilitating greater self-determination among students with I/DD (Wehmeyer 1999). Here, this is accomplished by providing the students a way to effectively take control of their own health, fitness, and physical activity by using a wearable device. This research also extends the research from Stanish and Frey (2008), which suggested that individuals with I/DD should be supported in choosing their own activities and making their own decisions during fitness-promoting activities. By wearing a Fitbit daily, monitoring their own activity via the Fitbit device and the Fitbit app, tracking their peers' activity levels, and receiving social reinforcement from their peers via the device and app, participants could make decisions as to how to attain more steps and how to more successfully compete with their peers, thus promoting self-determination. Silva and colleagues (2010) discussed that individuals without disabilities are more likely to be motivated towards physical activity when they are able to choose the types of physical activity in which he or she participates; this study indicates that this can also held to be true for young adults with I/DD.

This study also extends the research by providing naturally-occurring reinforcement within the app and the device itself. By participating in challenges via the Fitbit app, participants are reinforced for greater physical activity via competition with their peers, without needing an adult or teacher there to provide immediate reinforcement (Munson & Consolvo, 2012).

Limitations

While single subject research designs are useful when evaluating interventions to determine effects on individual participants, there are several limitations to this type of design as well. First, the small sample size (here, $n = 6$) limits external validity and generalizability. Replicating a study like this one with a larger sample size would improve generalizability. Further, all of the participants were from a similar background (i.e., students of similar socioeconomic status who are participating in a PSE), which also limits generalizability. Replicating such a study with more of a variety of students (for example, with young adults with I/DD who are not participants in a PSE or who have varying disabilities).

While this reversal design is effective in that it provides a quick, simple evaluation via immediate replication, it also has one key limitation. The dependent variable here, or number of steps taken each day, is one that can become a habit, so reversing a significant increase in daily step counts, and thus seeing a marked decrease during withdrawal phases, was unlikely. Second, the treatment effects of the independent variable, the app-based social reinforcement, were present even when the independent variable was withdrawn. The intervention required that the participants become "friends" within the Fitbit app. Once they knew how to see their friends' step counts within the app, most participants continued to try to compete with each other, even without the presence of an app-based challenge. Some participants even tried to start new challenges during the return to baseline conditions. These factors make exact replication a challenge.

Lack of data stability during both baseline and intervention phases was another limitation that was present in this study. Best practice indicates that in a reversal design such as this, the intervention should be introduced after stability has been established during the baseline phase (Gast & Hammond, 2010). Similarly, the intervention should be withdrawn after stability is achieved, as well. Here, however, stability was a challenge due to participants' inconsistent school schedules. For example, some days students had class in the same building as the PSE offices, while other days, their classes were up to a mile away on the other side of campus. This resulted in a much lower daily step count and made stability a challenge. In the interest of time efficiency, the researcher made the decision to center data collection around individual weeks and to place greater weight on overall step count averages instead of individual daily step counts.

Future Studies

These results indicate that continued use of social reinforcement within the use of wearable technology is an effective way to improve physical activity levels for individuals with I/DD. Further research would be beneficial in determining the extent of improvement as well as in exploring other potential types of effective social reinforcement within this context. First, data collection over extended periods of time would assist in determining whether the results can be considered a viable long-term solution for continued improved physical activity levels. Applying such an intervention across varied groups of participants (age, background, geographic location) would enhance external validity and generalizability. Future studies could also build in group and/or partner contingencies in order to incorporate social skills and further facilitate improvement. Finally, incorporating varied types of social reinforcement (e.g., rewards, social media groups, recognition) could assist in determining which type of intervention would be the most effective.

Summary

Increasing individual physical activity levels through increased daily step counts is one of many ways to improve overall health and fitness for individuals with intellectual and developmental disabilities. The use of wearable technologies in order to accomplish this is socially acceptable and promotes independence and self-determination. Social reinforcement is an effective way to increase physical activity levels through the use of such wearable technologies.

Chapter 4

Implications for the Future of Improving Physical Activity for Individuals with Intellectual and Developmental Disabilities

It has been established that individuals with intellectual and developmental disabilities typically engage in far less physical activity than does the general population (e.g., Barnes et al., 2013; Bodde et al., 2012a; Borremans et al., 2010; Esposito, et al., 2012; Finlayson et al., 2011; MacDonald et al., 2011; Peterson et al., 2008; Stanish & Draheim, 2005). It has also been established that regular physical activity can facilitate maintenance of a healthy weight as well as prevent obesity and other health problems (CDC 2014). While there are a variety of options for health, fitness, and physical activity for the general population, there are a number of barriers that tend to prevent individuals with I/DD from actively participating in health and fitness promotion activities as well as from attaining the recommended daily activity. These barriers include, but are not limited to, limited availability of programs for individuals with I/DD (Bartlo & Klein, 2011), unclear policy and ideas as to how to promote physical activity in this population (e.g., Messent et al., 1999; Temple & Walkley, 2007), and lack of motivation within individuals with I/DD (e.g., Heller et al., 2002; Heller et al., 2004).

The goal of this dissertation was to address some of these barriers by applying some of the strategies that have been identified as being best practices within physical activity promotion for individuals with I/DD. More specifically, the purpose of this dissertation was to implement two separate single-subject design studies utilizing wearable technology, the Fitbit, that would (1) evaluate the effects of a goal-setting intervention on the physical activity levels of college students with I/DD as measured by step counts, and (2) to examine the effects of social reinforcement delivered via the technology's associated app on the physical activity levels of college students with I/DD as measured by step counts. Results from both studies indicated that all participants improved their step counts during the interventions. In study 1, visual analysis demonstrated that the goal-setting intervention was an effective way to improve step counts as well as assist participants in finding more consistency from day to day. In study 2, visual analysis demonstrated that incorporating peer mentors and social reinforcement via the Fitbit app helped students increase physical activity level via average weekly step counts. Further, social validity questionnaires from both studies indicated that students found the interventions to be socially appropriate, fun, and helpful when tracking and improving activity levels.

Wearable Technology

Results from this study support a line of previous research that tracked activity level of individuals with I/DD via accelerometers or pedometers (e.g., Bodde et al., 2013; Frey et al., 2005; Phillips & Holland, 2011; Stanish 2004; Stanish & Draheim, 2005; Stanish & Draheim, 2007); Temple et al., 2000; Temple & Walkley, 2003). These studies found wearable technologies (accelerometers and pedometers) to be effective and efficient ways to measure physical activity of individuals with I/DD and to then compare activity levels to those of the general population.

However, while these studies tracked activity levels, they only measured them with the intent to compare with that of the general population (Phillips & Holland, 2011), examine perceptions of physical activity (Frey et al., 2005), correlate with skills and awareness (Bodde et al., 2013), and compare with recommended activity levels (Temple et al., 2000). They did not, as the study here, set out to improve the physical activity level of individuals with I/DD. Therefore, the research in this dissertation extends the literature by implementing effective interventions that improved physical activity levels as measured by an accelerometer, the Fitbit.

Both interventions successfully improved students' physical activity levels as measured by daily step counts.

Self-Management and Goal Setting

These findings support a number of previous studies that identified self-management, goal setting, and persuasive technologies as effective ways to address and improve physical activity in the general population. Baghurst et al. (2015) discussed the importance of goal setting in physical education settings, in particular, allowing students to set their own goals and providing feedback and assistance during the process. Consolvo et al. (2004) identified a number of ways to combine goal setting with persuasive technology in order to improve physical activity. Munson and Consolvo (2012) discussed in great length the use of mobile technology for improved health and fitness, in particular, the addition of daily reminders and goal setting within the technology. The present research supports all of these studies. It allows students to set their own goals with assistance and feedback (Baghurst et al., 2015); it combines goal setting with persuasive technology, the Fitbit, in order to increase activity levels (Consolvo et al., 2004); it includes daily reminders and goal setting within the Fitbit app (Munson & Consolvo, 2012).

In terms of individuals with I/DD, this research supports the assertion by Stanish and Frey (2008) that goal setting should be incorporated into health and fitness promotion programs for this population. By successfully incorporating a goal-setting intervention in order to improve participants' activity levels, this research supports their recommendation and demonstrates its efficacy.

The primary manner in which the present research extends previous research is that the participants in these studies were individuals with I/DD, whereas the majority of previous research has focused on individuals from the general population, without I/DD (e.g., Rimmer, 1999; Spanos et al., 2013; Stanish & Frey, 2008; Temple et al., 2006). Todd and Reid (2006) determined that an intervention that included self-monitoring could improve overall physical activity levels in this population, and Coleman and Whitman (1984) discussed positive changes in exercise behavior resulting from self-monitoring. However, there is little to no additional research that has explored this area, in particular, the use of wearable technology to improve activity levels for individuals with I/DD. This dissertation indicates that self-management and self-monitoring via wearable technology is an appropriate and effective strategy to increase activity levels, thus extending the research base.

Social Reinforcement

Both studies also support previous research on the use of social reinforcement for individuals with I/DD. Social reinforcement, such as praise, attention, and encouragement, have long been used as an effective way to strength or increase a variety of target behaviors in children and adults with I/DD (Wolery et al., 1998). By successfully providing social reinforcement through the wearable technology's associated app, this study supports the use of social reinforcement to increase a target behavior (e.g., daily step counts). Social reinforcement in terms of health and fitness interventions specifically has been limited until this point, however, a handful of interventions have also successfully incorporated social reinforcement as a secondary component (e.g., Croce & Horvat, 1992; Dunn et al., 1999).

The success of the second intervention of this study, in particular, also supports the line of research that identifies fun activities that reinforce social skills, as well as the use of peer mentors and community and social activities, as ways to address health, fitness, and physical within this population (e.g., Bazzano et al., 2009; Lotan et al., 2006; Marks et al., 2013, Stanish

& Frey, 2008). It extends this recommendation by incorporating the social reinforcement into the intervention itself.

These studies extend the research on social reinforcement in a number of ways. First, it demonstrated that social reinforcement can be successfully delivered virtually, as the social reinforcement incorporated here was via in-app messages as well as virtual praise and attention. It also extends the current research by providing variety in the manner in which the reinforcement is delivered; instead of only being delivered in person by a caregiver or teacher (Croce & Horvat, 1992), it was delivered virtually by peers with and without disabilities. Further, this research demonstrates that an intervention whose primary component is social reinforcement can be an effective way to improve physical activity levels, as until this points, social reinforcement has been a secondary component of health and fitness interventions for this population. Finally, this research applies the use of social reinforcement to an area of study to which it has not been greatly applied, the promotion of physical activity in individuals with I/DD.

While the social reinforcement component of this intervention was generally effective in increasing physical activity levels for most participants, it should also be considered that there may be other factors at play which led to a general increase in step counts. For students with autism in particular, it is difficult to say whether the social reinforcement piece was the primary reason that students increased step counts, as students with that particular type of disability do not tend to be quite as motivated by friends and social activities. Additionally, as the Fitbit app also includes other methods of reinforcement in addition to the social component during in-app challenges, it is difficult to say whether the reinforcement provided by peer mentors was indeed responsible for the increase in step counts during intervention weeks.

The research here also provides further insight and exploration into the question of what is or is not reinforcing about physical activity as opposed to a sedentary lifestyle, which was identified by Epstein (1998) as an area that needed more research. By exploring the use of wearable technology with the goal to motivate participants to become more physically active, this research provides valuable insight into what works when participants become engaged in a more active lifestyle. It both supports and extends research from Buckworth and Nigg (2004): it implements an intervention whose goal is ultimately to be more rewarding than would being sedentary while also demonstrating that such an intervention is effective.

Self-Determination Theory

This dissertation supports and extends the literature on self-determination theory (SDT) as it applies to health, fitness and physical activity for individuals with I/DD. Both of the interventions examined in this research fit into the SDT framework and allow participants to become self-determined in their own physical activity, as they were able to choose, monitor, and manage their physical activity and fitness via the Fitbit (Van den Berghe et al., 2014).

The interventions in this research fit into the SDT framework by fulfilling each of the three basic needs that Deci and Ryan (2000) identified as necessary for being self-determined: autonomy, competence, and relatedness. Autonomy, or the ability to make one's own choices, was achieved by allowing students to determine the type of physical activity in which they would like to participate, if any at all, as they monitored their own step counts. Lonsdale and colleagues (2013) indicated that autonomy was increased when individuals were given free choice over their physical activity, and the studies in this dissertation provided for this autonomy. The second basic need of competence arguably has the greatest effect on increasing physical activity (e.g., George et al., 2013; Ntoumanis 2001; Wilson & Rogers, 2008). The studies here allowed for competence in two ways: first, by providing students with a wearable device and associated app that were easy to use and monitor, and second, by encouraging walking as the primary form of physical activity. Students were able to partake in other types of physical activity if they chose to, however, they were able to fully and successfully participate in the intervention through walking. Relatedness, the third basic need, or a “sense of belongingness and connectedness to the persons, group, or culture disseminating a goal” (Ryan & Deci, 2000a, p. 64), was also accomplished in two ways: first, by goal-setting sessions that were completed with the lead researcher, and second, by incorporating peer mentors and friends via the Fitbit app.

By successfully incorporating each of the three basic needs from SDT, this dissertation extends the research by also demonstrating that SDT pertains to exercise behaviors of individuals with I/DD, as well. These studies also add to the current research base that incorporates the SDT framework in regards to motivation, as seeing individual improvements in activity levels here can provide valuable insight in determining what does and does not motivate individuals with I/DD.

Deci and Ryan (2000) also indicated that individuals become self-determined once they are able to internalize the goal and become intrinsically motivated. They referred to this as assimilation, when individuals are able to incorporate environmental norms (Deci & Ryan, 1985a; Ryan et al, 2009). By providing participants with wearable technology that they found inherently enjoyable and valuable, they, over time, became more intrinsically motivated to continue to increase step counts and set goals around their activity levels. The Fitbit technology was motivating to the participants, and by wearing it consistently, they were able to work towards becoming self-determined in taking more steps each day.

Limitations

There are several limitations of this research that require readers to use caution in interpreting the results. Moreover, replication of both studies is in order. First, several limitations inherently exist within single-subject research designs, which both of these studies used. Both used a small sample size ($n = 4$ and $n = 6$, respectively), which limit external validity and generalizability. Further, all students who participated in these studies were from the same PSE program in the same region of the country. For that reason, they were all from similar socioeconomic backgrounds and similar families.

Another limitation was the lack of data stability, throughout both baseline and intervention phases, during both of the studies. Best practice in single-subject research designs is to achieve stability before introducing any type of intervention (Gast & Hammond, 2010). Because of participants' inconsistent school schedules, with classes and events in different buildings of campus on different days, achieving consistency was a challenge, particularly within the given timeframe. Previous research has demonstrated that it often takes time to achieve significant, consistent improvement; Rogers and colleagues (2005) found that after implementing an intervention which aimed to improve step counts, participants did not see significant or regular improvements until the fifth week of the intervention.

The academic schedule and the length of the school semester were also limitations. While it was enough time to see some great improvements in step counts, it would have been a much stronger study if the intervention could have taken place over an entire school year. Further, there were several breaks during the semester that made device distribution, and in Study 1, consistent goal setting a challenge.

Another limitation was the participants' reliance on the researcher for device distribution, return, charging, etc. Participants were not permitted to take the devices home over the weekend, so the distribution on Mondays and return on Fridays took a great deal of communication between the researcher and participants. On a few occasions, participants forgot to return the devices on Friday afternoon and would have to keep them over the weekend, when the device would lose its charge and thus need to be charged on Monday upon return to school; this would then results in missed data collection for that particular day (and therefore no data point for that particular day). While the schedule helped decrease the chance of lost devices over the weekend and increase the likelihood that devices remained charged during the school week, it ended up being quite a logistical challenge. Further, it took away from participants' independence and their ability to be self-determined in the use of the wearable technology. In future research, a more efficient schedule could be implemented, however, this will probably require some trial and error in order to determine exactly what that would be.

The absence of data to determine long-term effects of the interventions is also a limitation. While participants wore the devices for, more or less, two full semesters, some sort of inquiry into whether the students continued to be physically active at their goal level would be appropriate.

The possibility that the novelty of the Fitbit may have played a role in increased step counts should also be considered a limitation of both studies here. The Fitbit Blaze was something that participants were very excited to wear and to use at first, which could have led to higher step counts than they would have had with a less novel device. This was primarily a limitation that was present during baseline phases, however, it should be considered for all phases of both studies as well.

Future Research

There is great room for growth in the field of health, fitness, and physical activity promotion for individuals of all ages with I/DD, as there is a great deal that is missing from it now. Promoting physical activity in this population could be a key factor in improving their overall health and living longer, more fulfilled lives (Rimmer, 1999). Further, by providing more opportunities for individuals with I/DD to become self-determined, this could lead to a greater overall quality of life.

This dissertation demonstrated the effectiveness of interventions using wearable technology that aimed to improve physical activity levels of individuals with I/DD. In order to address specific limitations from these studies, additional research is needed to determine whether other types of social reinforcement are more effective, what the long-term effects of such an intervention are, and how such interventions might impact other types and larger groups of participants. Future studies could also incorporate a control group for comparison.

Throughout both studies, participants often requested prizes for the most steps, most improvement, etc. They also started to challenge each other and check on each other's step counts even outside of goal-setting phases and in-app challenges. For these reasons, future studies that incorporate individual and group contingencies and other types of reinforcement would be appropriate. Further, additional studies like this would be in line with the recommendation from Oviedo and colleagues (2014), which indicated that the most effective specific type of physical activity intervention for this population is currently lacking in the literature. By continuing to explore a variety of types of interventions, future research can come closer to determining what is the most effective for this population.

Future research could also include families and/or care assistants in the interventions. While most of the steps in participants' step counts happened while at school, students also wore their Fitbits at home during the school week. Thus, participation by families may have impacted the intervention. This would align with the recommendation from Stanish and Frey (2008) that caregivers not only be included, but that they also have the knowledge and skills to facilitate physical activity and a general healthy lifestyle.

It is also appropriate to compare the two independent studies in terms of effectiveness. While they both had the same end goal – to increase physical activity levels as measured by step counts – each study approached this goal in a very different way.

Based on visual analysis, the goal-setting intervention demonstrated a clear functional relation, as demonstrated by participants achieving the target goal during each phase for three consecutive data points. Participants were able to consistently and systematically increase their daily step count and average step count over the course of the intervention phases. However, it took several participants quite some time to achieve their goals during the intervention phases and to thus find consistency. The best example of this is Elisa, who, during goal 1 phase, took 8 days until she was able to reach her goal for 3 consecutive days. The lead researcher reported that overall, during the intervention phases, it did not necessarily feel as if the participants were making progress, as the inconsistency from day to day made achieving goals a challenge.

While the social reinforcement intervention in study 2 did not demonstrate a functional relation quite as clearly as did the goal-setting intervention, the lead researcher reported that participants were more excited about it, they enjoyed the challenges more than they seemed to enjoy setting goals (at least for participants Archie, Elisa, and Carter, who completed both studies), and it was a much more interactive process. Once participants were introduced to the challenges, they started creating other challenges within the app, as well. They also were often found checking the Fitbit app on their devices and showed other participants and the lead researcher that they were receiving messages within the app.

Based on the data and researcher observations, it would be appropriate for future studies to directly compare these two types of interventions, as well as other potential interventions, when assessing which type of intervention is the most effective. It would also be beneficial to note the disability category and personal characteristics of each of the participants when making these comparisons, as these factors may play a role in which intervention is most effective.

More broadly, there is a need for "well-designed, accessible, preventive health promotion strategies and interventions designed to raise the levels of physical activity for individuals with intellectual disability which take into account the unique barriers to physical activity this group faces" (Phillips & Holland, 2011, p. 6). One way to address this would be by including such interventions in larger health promotion and education efforts (e.g., Abdullah et al., 2004; Bazzano et al., 2009; Havercamp et al., 2004; Marks et al., 2013; Stanish & Frey, 2008). The participants in this study did receive some health and fitness education as part of a Life Skills course in the PSE curriculum; however, it was not a key component of the interventions. A specific education component that included rationale for physical activity, strategies to achieve certain physical activity levels, and the importance of an overall healthy lifestyle
Future research could take the lead of programs such as the Healthy Lifestyle Change Program (Bazzano et al., 2009), which incorporated health, exercise, and nutrition education, and add in a component to include monitoring of activity levels via wearable technology. It could also include ideas and guidance for weight loss, including nutrition education, self-monitoring, and goal setting (Marks et al., 2013).

Additionally, future studies could incorporate the monitoring of more activities than solely step counts. This way, students could become more proficient in tracking all of their activities and setting goals around their activity and fitness levels. Finally, continued incorporation of peer mentors and implementation of community-based activities, but utilizing the mentors and community activities in different ways (e.g., removing the specific reinforcement from peers, conducting goal-setting sessions with peers, using groups on social media for reinforcement, posting progress to social media, etc.) would be appropriate future strategies to implement in exploring best practices.

Finally, studies like the ones presented in this dissertation could contribute greatly to the growing body of research in this area if they tied together these results with more fitness-specific assessments, such as performance levels, ability, body composition, and exercise behavior. For example, it would be helpful to coordinate these interventions with body composition assessments to determine if increased physical activity also led to a loss in body fat or an increase in lean muscle. Another example would be incorporating performance- or skill-based assessments to determine whether increased overall activity level can play a role in improving general fitness performance, as well.

Summary and Conclusions

There are a number of possibilities when considering health, fitness, and physical activity promotion and intervention for individuals with I/DD. As research in this field is so new and relatively scarce, educators, caregivers, fitness experts, and health professionals should try a variety of interventions in order to grow the body of research and determine what is most effective. Wearable technologies are one way to track fitness and activity levels and allow individuals to become more independent and self-determined in terms of health, fitness, and physical activity. Both self-management and social reinforcement strategies can be effective and have the potential to facilitate great improvements in activity levels. Improved activity levels can then lead to longer lives, fewer health problems, and a greater overall quality of life.

While this dissertation is only a start, it is one that can contribute to and extend the current body of research in this growing field. Young adults with I/DD have just as much potential and just as much need to be physically active and healthy as do young adults without disabilities. Fitness and health can potentially open doors that they may not have anticipated being opened and can truly empower them to become healthier inside and out.

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Appendices

Appendix A. Procedural Reliability Data Sheet
Study 1.

Data Collector: ___________________________ Date: __________________

	Observed
1. Review of baseline data/data from previous phase (printed data sheets from Fitbit.com)?	YES NO
2. Computation of averages completed in presence of participant?	YES NO
3. Goal number of steps for next phase completed?	YES NO
4. Discussion and corresponding notes on how to attain the goal number of steps?	YES NO
5. Fitbit app updated to reflect new goal number of steps?	YES NO

TOTAL: __________________/____________________ = _____________%

Appendix B. Social Validity Worksheet
Study 1.

Name: ____

Date: ____

1 Strongly agree	2 Agree	3 Neutral	4 Slightly disagree	5 Strongly disagree

1. I liked using a Fitbit to track my activity level.	1	2	3	4	5
2. Using a Fitbit was helpful in keeping track of my activity levels.	1	2	3	4	5
3. I liked wearing a Fitbit every day.	1	2	3	4	5
4. The Fitbit app was easy to use.	1	2	3	4	5
5. I liked setting goals for number of steps each week.	1	2	3	4	5
6. Setting goals helped me to take more steps every day.	1	2	3	4	5
7. I liked when the app told me that I reached my goal number of steps.	1	2	3	4	5
8. During goal-setting sessions, I was able to brainstorm ways that I could increase my number of steps to reach my next goal.	1	2	3	4	5
9. I think that setting goals affected my activity level.	1	2	3	4	5
10. I like setting goals and want to set goals in other parts of my life, too.	1	2	3	4	5
11. I want to keep using a Fitbit.	1	2	3	4	5
12. I want to keep setting goals.	1	2	3	4	5
13. Being able to choose activities that would help me reach my goal actually helped me increase my physical activity level.	1	2	3	4	5
14. I feel that I am capable of determining how to get more physical activity each day.	1	2	3	4	5

15. What did you like or not like about the Fitbit and the Fitbit app?

16. What was it like to use the Fitbit and the Fitbit app?

17. Any other thoughts about the Fitbit, goal setting, or physical activity?

Appendix C. Procedural Reliability Worksheet.
Study 2.

Data Collector: ___________________________ Date: __________________

	Observed
1. Student is wearing Fitbit?	YES NO
2. Fitbit is charged?	YES NO
3. Fitbit is synced with student's iPad and/or mobile device?	YES NO
4. In intervention phase, WorkWeek Hustle challenge has been initiated?	YES NO
5. Each student has been invited to and accepted WorkWeek Hustle challenge?	YES NO
6. Student has opened Fitbit app to see that WorkWeek hustle challenge has started?	YES NO
7. Lead researcher has reviewed how to check Fitbit app and how to see progress within the challenge?	YES NO

TOTAL: __________________/____________________ = _____________%

Appendix D. Google Forms Survey for Peer Mentors
Study 2.

Email Address:	
Name:	
Buddy's Name:	
Did you send a message within the app each day?	
What types of messages did you send?	
Which type did you use most frequently?	

Appendix E. Social Validity Worksheet.
Study 2.

Name: ____

Date: ____

1	2	3	4	5
Strongly agree	Agree	Neutral	Slightly disagree	Strongly disagree

1. I liked using a Fitbit to track my activity level.	1	2	3	4	5
2. Using a Fitbit was helpful in keeping track of my activity levels.	1	2	3	4	5
3. I liked wearing a Fitbit every day.	1	2	3	4	5
4. The Fitbit app was easy to use.	1	2	3	4	5
5. I took more steps during a challenge than I did when there was not a challenge.	1	2	3	4	5
6. The challenges were fun for me.	1	2	3	4	5
7. I liked seeing the number of steps that my friends were taking every day during the challenge.	1	2	3	4	5
8. I can give examples of ways to take more steps each day.	1	2	3	4	5
9. I want to continue to be more physically active every day.	1	2	3	4	5
10. I think that challenges like this could help me in other areas of my life, too.	1	2	3	4	5
11. I want to keep using a Fitbit.	1	2	3	4	5
12. I enjoyed the social part of the challenges.	1	2	3	4	5
13. Remaining connected with my friends throughout the challenges played a big role in helping me to increase my activity level.	1	2	3	4	5
14. I feel that I am capable of determining how to get more physical activity each day.	1	2	3	4	5

15. What did you like or not like about the Fitbit and the Fitbit app?

16. What was it like to use the Fitbit and the Fitbit app?

17. Any other thoughts about the Fitbit, the challenges, or physical activity?

Vita

Kelly Kraiss is originally from Orlando, Florida and attended Dr. Phillips High School. She then moved to Knoxville to attend the University of Tennessee, Knoxville. She graduated Summa Cum Laude with a B.S. in Human Ecology, concentration in Early Childhood Special Education, and was a four-year letter winner as a member of the women's rowing team. After graduation, Kelly taught preschool and Kindergarten special education in Orlando, Florida, for 4 years, during which time she completed her Masters degree in Exceptional Education from the University of Central Florida with a concentration in Autism Spectrum Disorders. Kelly then moved to New York City to attend Brooklyn Law School, where she focused her studies and experiences on criminal law, prosecution side. She graduated in 2010 and became a member of both the Virginia and Florida Bars. In 2010, Kelly returned home to Orlando, where she worked for several schools in special education compliance/staffing, and then for Seminole County Public Schools in central Florida, also doing compliance/staffing. At this time, Kelly decided to return to Knoxville to pursue her Ph.D. in Special Education at the University of Tennessee. There, she worked as a graduate assistant, where she taught both undergraduate special education courses as well as a Life Skills course for the FUTURE postsecondary program for students with intellectual and developmental disabilities. Kelly will receive her Ph.D. in May of 2017.