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Evaluating the Effectiveness of Goal Setting and Textual Feedback Using a Wearable Technology for Increasing Running Distance

Michael Zarate
University of South Florida, zaratem@mail.usf.edu

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by

Michael Zarate

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Major Professor: Raymond G. Miltenberger, Ph.D., BCBA-D
Kimberly A. Crosland, Ph.D., BCBA-D
Kwang-Sun Cho Blair, Ph.D., BCBA-D

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ABSTRACT

Obesity is a growing problem that has life-threatening health consequences. One way to combat obesity is by increasing physical activity levels, which has been a focus of recent applied behavioral research. The purpose of this study was to evaluate the effectiveness of goal setting and textual feedback without social support to increase physical activity, specifically weekly running distance. A multiple-baseline across participants design was employed with four participants using a Fitbit Flex accelerometer to collect two physical activity measures, intense steps and distance. Results showed a significant increase in weekly running distance for two out of four participants following the intervention.

INTRODUCTION

The obesity epidemic in the United States is a serious problem that affects millions of citizens, including people of all ages and backgrounds. The percentage of American adults who suffer from obesity dramatically increased from 13.4% in 1980 to 34.3% in 2008. More alarmingly, obesity in American children more than tripled from 5% in 1980 to 17% in 2008 (U.S. Department of Health and Human Services, 2010). The most recent data show that during 2011-2014, the prevalence of obesity in the United States was 36.5% among adults and 17% among youth aged 2-19 years old (Centers for Disease Control and Prevention, 2015). It is estimated that there are approximately 112,000 preventable deaths in the United States each year linked to the obesity epidemic (U.S. Department of Health and Human Services, 2010).

Obesity in adults poses many serious health risks, such as an increased risk in developing "high blood pressure, high cholesterol, type 2 diabetes, coronary heart disease, stroke, gallbladder disease, osteoarthritis, sleep apnea, and respiratory problems, as well as endometrial, breast, prostate, and colon cancers" (p. 2, U.S. Department of Health and Human Services, 2010). Although various methods can be used to combat obesity, one method is to increase the amount of physical activity a person engages in on a daily or weekly basis. People of all ages, genders, and backgrounds benefit from engaging in physical activity regularly. In doing so, one may reduce the risk of premature mortality due to coronary heart disease, hypertension, colon cancer, and diabetes mellitus, while also improving mental health and the health of muscles, bones, and joints (U.S. Department of Health and Human Services, 1996).

Scheduling enough time to meet the recommended levels of physical activity is key to improving and maintaining the overall health of an individual. It is recommended that an adult engage in at least 150 min of physical activity per week that is of a moderate intensity (U.S. Department of Health and Human Services, 2008). Some of these activities may include brisk walking, running, doing yard work, and playing sports, among others (U.S. Department of Health and Human Services, 2010). Unfortunately, more than 60% of adults in the United States do not regularly engage in physical activity, and 25% of adults report that they are not active at all (U.S. Department of Health and Human Services, 1996). As is evident, the increasing number of obese, inactive Americans makes increasing physical activity a socially valid issue that must be addressed in behavioral research.

Physical activity levels have been assessed in research using different methods. Although self-report assessment may be the most convenient and unobtrusive method of collecting data on physical activity, research has shown that it may not be the most accurate method due to the subjectivity of data collection (Prince et al., 2008). Direct observation allows for a more accurate collection of data, however it is often impractical for researchers to observe all instances of physical activity as it occurs in the natural setting (McIver, Brown, Pfeiffer, Dowda, & Pate, 2009). Permanent product recording allows the researcher to assess physical activity levels accurately without the need to directly observe the behavior as it occurs. Many recent studies have used accelerometers, such as the Fitbit and Nike SportKit, to collect data that can be accessed as a permanent product at some time after the behavior has occurred (Kurti & Dallery, 2013; Valbuena, Miltenberger, & Solley, 2015; Wack, Crosland & Miltenberger, 2014; Washington, Banna, & Gibson, 2014).

A number of interventions have been implemented and evaluated for increasing physical activity levels. Goal setting is one of the most common and effective interventions that has been used to increase an individual's physical activity levels in a wide variety of community environments (Brobst & Ward, 2002; Hayes & Van Camp, 2015; Normand, 2008; Wack et al., 2014). Goal setting involves choosing a specific performance criterion that an individual strives to reach, and then systematically increasing that criterion level as the person achieves the previous performance level (Locke & Latham, 1990). Goal setting is often used in combination with other interventions, such as self-monitoring, performance feedback, public posting, and behavioral coaching (Brobst & Ward, 2002; Hayes & Van Camp, 2015; Normand, 2008; Valbuena et al., 2015; Wack et al., 2014), or monetary or other reinforcers (Ek, Miltenberger & Valbuena, 2016; Kurti & Dallery, 2013; Washington et al., 2014).

Goal-setting procedures have been combined most commonly with a treatment package that includes both self-monitoring and performance feedback procedures. Normand (2008) combined these three treatment components to increase daily step counts for four healthy adults using a multiple-baseline across participants design with an embedded reversal component for each participant. The goal-setting procedure involved participants setting daily step goals based on their average daily steps taken in the previous week. Daily steps were tracked using a pedometer that each participant wore throughout the day. Participants were able to increase their daily step goal for the following week only if they reached their goal on 4 out of the 7 days that week. Self-monitoring involved daily reports of step counts to the researcher by email, and performance feedback involved delivery of praise or encouragement and a graphical review of the data from that week during a weekly meeting between the participant and the researcher. The results of this study showed an increase in daily step counts for all participants when the intervention was added, followed by a decrease in daily step counts when the intervention was removed. Step counts increased again when the intervention was re-added. These results show strong experimental control for increasing daily step count when goal setting is combined with self-monitoring and performance feedback.

Hayes and Van Camp (2015) combined goal setting with self-monitoring and feedback to increase the step counts of six school-aged girls during unstructured recess using a reversal design. The participants wore a Fitbit accelerometer during each session, and at the end of each session the researcher collected the device and recorded the number of steps taken during recess. Goal setting involved step goals that were set at a percentage increase above the average steps taken in previous sessions. In self-monitoring, participants were encouraged to frequently refer to their device display during recess time to track their step counts. They were also given slips of paper containing the current goal and previous session steps and were prompted to report if the goal was met when the session ended. Feedback involved the delivery of praise or encouragement by the researcher when recess ended, and a reinforcement component was also added in which participants received small tangible rewards for meeting goals. Results were similar to those found by Normand (2008), further showing the effectiveness of goal setting when used in a treatment package.

Wack et al. (2014) combined goal setting with performance feedback to increase running distance among five healthy adults using the Nike+ SportKit technology in a multiple-baseline across participants design with an embedded changing criterion design for each participant. In the first intervention phase, participants set short-term daily running distance goals and a long-term running distance goal of how far they would be able to run in one running episode by the end of the study. A second intervention phase was implemented for three participants who consistently failed to meet daily short-term goals, in which short-term goals were switched from daily to weekly running distance and the long-term goal was based on how far they would be able to run in one week by the end of the study. The feedback procedure for both intervention phases involved a weekly meeting with the researcher in which the researcher provided the participant with a verbal description of progress toward goals along with a graphical review of the data. Results showed that daily goal setting and feedback increased running distance for only two out of the five participants. However, weekly goal setting and feedback increased running distance for the three participants who were not successful during the daily goal-setting phase.

Although a number of studies have been conducted using goal-setting procedures, these studies have incorporated a feedback component involving social support from the researcher (Hayes & Van Camp, 2015; Normand, 2008; Wack et al., 2014). In each study, the results showed that the treatment packages increased physical activity, but it is unclear how much of the effect was due to the direct contact and feedback provided by the researcher. For this study, social support was defined as any direct interaction and/or contact between the researcher and participant. Neutral reports of performance and goals via text message using a pre-constructed template will not be considered social support. According to Wack et al. (2014), further research is needed in this area to evaluate the effectiveness of goal setting without social support from the researcher. By minimizing the amount of direct contact between the researcher and participants throughout the study, the effect of goal-setting procedures on physical activity levels will be clearer. Therefore, the purpose of this study was to evaluate the effectiveness of goal setting and textual feedback without social support to increase physical activity, specifically running distance. Although Wack et al. (2014) measured running distance as the dependent variable, most research on increasing physical activity has focused on using step count as the dependent variable (Hayes & Van Camp, 2015; Kuhl, Rudrud, Witts, & Schulze, 2015; Kurti & Dallery, 2013; Normand, 2008; Valbuena et al., 2015; Washington et al., 2014). Step count is a meaningful dependent variable when measured with a reliable and accurate device, however, it is limited because it does not provide a measure of exercise intensity. Fortunately, accelerometers like Fitbit record information on the timing and number of steps taken and categorize them into light, moderate, or intense activity. This study measured weekly running distance by converting the intense steps recorded by the Fitbit into miles.

METHOD

Participants and Setting

Four healthy adults, ages 21 to 24 years old, participated in this study. Participants were recruited using flyers posted around local gyms. The recruitment flyers provided the researcher's contact information, inclusion criteria for participating in the study, and an approximate length of time the study would last. The researcher provided potential participants with the informed consent form, reviewed the study, and answered any questions before accepting participants into the study. Additionally, participants were given the Physical Activity Readiness Questionnaire (Thomas, Reading, & Shephard, 1992) to determine potential health risks associated with increasing physical activity and exercise (see Appendix A) and the Locus of Causality for Exercise Scale (Markland & Hardy, 1997) to assess self-determination and motivation to engage in exercise (see Appendix B). Inclusion criteria for participation in the study included the participant being between 18 and 45 years old, averaging a 4 or higher on the Locus of Causality for Exercise Scale (LCES), answering "no" to all questions on the Physical Activity Readiness Questionnaire (PAR-Q), agreement to continue participating in the study until long-term goals are met, ability to communicate with the researcher via text or email, and planning to return all materials to the researcher at the conclusion of the study (see Appendix C). Participants were accepted into the study upon completing the PAR-Q and LCES, completing the inclusion criteria form and meeting all requirements, and signing informed consent. Adam was a 21 year-old man who was an undergraduate student at a local community college and working part-time at an electronics store. He scored a 6.67 on the LCES. Mary was a 21 year-old woman who was going to school to obtain her cosmetology license and working as a server at a restaurant. She also scored a 6.67 on the LCES. Tom was a 23 year-old man who was in firefighter school and working as a part-time cook at a restaurant. He scored a 5.33 on the LCES. Zeke was a 24 year-old man who was an online graduate student and working in a children's therapy clinic. He scored a 5.67 on the LCES. Scores on the LCES range from 1 to 7 with higher scores indicating greater "self-determination" for exercise. The study took place in the participants' natural environments, where each participant engaged in running and/or other exercise on a daily basis, such as the home, gym, a local park, or a running trail. Participants were provided with a Fitbit Flex wearable device and instructed to wear it across all settings throughout the day from the time they awoke to the time they went to sleep.

Materials

The Fitbit Flex device was used to track daily intense steps, which we then converted into an approximate distance measure. The participants used the device to upload their data to the Fitbit website for the researcher to review daily, although the participants could not access the website. The Fitbit Flex display consists of five lights that light up as progress towards a pre-set goal of 10,000 steps is made. This goal was not modified in participant's accounts at any point of the study. The device does not have a digital display that shows the current step count. Participants had access to a phone or laptop to communicate with the researcher throughout the study.

Validity and Reliability of the Fitbit

Prior to beginning the study, the researcher tested the validity and reliability of the Fitbit Flex's step function. To test reliability, a participant wore two devices at the same time and ran for two 5-min sessions. Data were collected on the number of steps recorded on both devices. The researcher calculated the percentage of agreement for number of steps between the two devices by dividing the lower step count by the higher step count and multiplying the value by 100. The percentage of agreement between the two devices for each session was 99.5% and 99.8%. The overall reliability of the Fitbit Flex's step function was 99.7%.

To test validity, a participant wore one device and ran for two 5-min sessions. Data were collected on the number of steps recorded on the device. Additionally, the researcher observed the participant and independently recorded the number of steps taken during both sessions using a counter. The researcher calculated the percentage of agreement for number of steps between the step count recorded by the device and the step count recorded by the researcher by dividing the lower step count by the higher step count and multiplying by 100. The percentage of agreement between the device and the researcher's counter for each session was 88.4% and 89.4%. The overall validity of the Fitbit Flex's step function was 88.9%. In each case, the Fitbit counted fewer steps than the observer.

Target Behavior and Data Collection

The behavior targeted for increase in this study was weekly running distance. Participants were instructed to wear the Fitbit Flex during all waking hours. The Fitbit records the steps that participants take throughout the day, reports them in 15-min intervals, and shows the steps in each interval in a bar graph with a yellow bar for light intensity steps, a brown bar for moderate intensity steps, and a green bar for high intensity steps. The greater number of steps in an interval is associated with a greater intensity shown in the interval. The Fitbit also shows steps in 5-min intervals. We observed that the 5-min intervals corresponding to each 15-min interval with high intensity steps had at least 400 steps per 5 min. Participants were instructed to upload their Fitbit

Flex data to their respective Fitbit accounts at the end of each day. The Fitbit Flex data were either uploaded manually by the participant or automatically when the device came within close proximity to a synced laptop or computer. Participants did not have access to the accounts, so they uploaded the data without knowing how many steps they had taken that particular day. Once the data were uploaded, the researcher reviewed the participant's daily steps and identified all 15-min intervals that had green bars indicating high intensity steps. The researcher then recorded all steps in 5-min intervals that had at least 400 steps. Because they were high intensity steps, they were considered steps taken while running. The weekly running distance was then estimated by adding all high intensity steps from Monday through Sunday and dividing by 2,000, the approximate number of steps in one mile (Hoeger, Bond, Ransdall, Shimon, & Merugu, 2008).

Interobserver Agreement (IOA)

The researcher and a research assistant assessed IOA by independently recording the date, intense steps, and distance during intense steps from the Fitbit website on 100% of days across both phases. Daily intense steps and distance values had to be exactly the same to be considered in agreement. IOA was calculated by dividing the number of agreements by the number of opportunities, then multiplied by 100. IOA was 100% across baseline phases and 99% across goal-setting phases.

Treatment Integrity

Treatment integrity was assessed during the goal-setting phase to assure that goal setting and feedback were implemented as planned but that social support was not provided throughout the intervention and textual feedback remained neutral and consistent each week. The researcher developed two text message templates, one template to be sent to participants at the end of each week if their weekly running distance goal had been met and the other template to be sent to participants if their goal had not been met. The text message template for goal attainment read: "Your weekly running distance goal of __ miles (__ intense steps) has been met with a total of __ miles (__ intense steps) run this past week. Your new running distance goal for this week (MM/DD/YYYY-MM/DD/YYYY) is __ miles (__ intense steps)." The text message template for goal failure read: "Your weekly running distance goal of __ miles (__ intense steps) has not been met with a total of __ miles (__ intense steps) run this past week. Your running distance goal will remain the same for this week (MM/DD/YYYY-MM/DD/YYYY) at __ miles (__ intense steps)." The researcher took screenshots of each text message sent to participants at the beginning of each week and reviewed each text at the end of the study to make sure all messages followed the templates exactly. This assured that all feedback provided to participants was limited to the same neutral report of performance and goals each time. Treatment integrity was 100% across all weekly text messages, demonstrating successful adherence to the protocol.

Social Validity Assessment

Participants were given a 13-item social validity questionnaire to assess their satisfaction with the interventions and to assess if they found the interventions to be effective (see Appendix D). The first seven items were answered using a 5-point Likert scale (1 = *strongly disagree*, 2 = *somewhat disagree*, 3 = *neutral*, 4 = *somewhat agree*, and 5 = *strongly agree*). The following statements were included in the first section of the social validity questionnaire: the study did not require too much time or effort to participate in (*M=3.5)*; I would continue using the procedures used in this study to increase running distance or other physical activity (*M=5)*; I run longer distances per week than before participating in this study (*M=4.75)*; this study was effective in increasing my physical activity levels (*M=5)*; I enjoyed participating in this study (*M=4.5)*; I liked the procedures used in this study (*M=4)*; I would recommend this study to others (*M=4.5)*.

The next six questions were answered in a free response format. The following statements or questions were included in the second section of the social validity questionnaire: How did the procedures influence your running? Describe the way in which you kept track of your running distance throughout each week. What strategies did you use to increase your running distance once you started using goal setting? Did you use any other apps or devices to track your running distance or to help you run more? Where did you engage in running during the study (e.g., treadmill, outdoor track, streets, trails, etc.)? Did you engage in any other types of physical activity that may have led to running distance being recorded on the Fitbit? (e.g., basketball, soccer, softball, etc.) Average scores on the Likert scale questions for Adam, Mary, Tom, and Zeke were 4.6, 4, 4.9, and 4.4, respectively. See Table 1 (p. x) for scores on each Likert scale item by participant and Table 2 (p. x) for responses to each free response item by participant.

Experimental Design

A multiple-baseline across participants with an embedded changing criterion experimental design was employed to assess the effectiveness of goal setting without social support to increase weekly running distance for four healthy adults. The number of weeks spent in baseline was staggered across each participant.

Procedure

Baseline. In baseline, the researcher provided participants with a Fitbit Flex device that was covered with tamper-evident tape to shield the participants from seeing the device's display screen. Participants were instructed to wear the device every day from the time they awoke to the time they went to sleep. Wearing the device throughout the entire day was necessary for reducing reactivity of putting the device on and off during the day just for running and for avoiding situations in which a participant engaged in running without wearing the device. The researcher provided no specific instructions for engaging in physical activity or running. Each device was linked to a Fitbit account that the researcher accessed through the Fitbit website. Participants were told to upload their data to their accounts daily but were not given the account login information to review their data. To establish a contingency for wearing the device and uploading data daily, participants were informed that they could earn $5 for uploading 93% of their daily data every two weeks. The researcher logged in to each account at the end of the day and collected data on whether each participant wore the device throughout the day and uploaded his or her data at the end of the day.

Goal setting and textual feedback. Following the baseline phase, the researcher met with each participant to remove the tamper-evident tape from the Fitbit Flex device and to establish short-term and long-term goals for the goal-setting phase. With the tape removed from the device, participants were able to view the device's display screen. However, participants still did not have access to log in to their Fitbit accounts on the Fitbit website. The researcher discussed with each participant how far he or she would like to be able to run in one week by the end of the study. Weekly long-term goals for Adam, Mary, Tom, and Zeke were 14 mi, 8 mi, 6 mi, and 7 mi, respectively. The researcher then established an initial weekly running distance goal at 10% higher than the participants' mean weekly running distances during baseline. If a participant's baseline average was well below one mile, their initial short-term weekly running distance goal was set at a minimum of one mile. Subsequent weekly goals were established at 10% higher than the previous week's goal level. If a participant met the criterion level for that week's goal, he or she increased the short-term goal for the following week. If a participant did not meet the criterion level for that week, he or she remained at the same goal level for the following week. If a participant substantially exceeded his or her weekly goal levels for two consecutive weeks, the following week's short-term goal was set higher than 10% above the previous week's goal level. Following the initial meeting at the start of the intervention phase, the researcher no longer met with the participants in person. This helped remove social support that may have otherwise contributed to the effectiveness of the goal-setting procedure. The researcher provided neutral feedback to each participant via text message on whether or not the goal was met at the end of each week along with his or her short-term goal for the following week based on meeting or not meeting the performance criteria in the previous week.

Table 1. Social Validity Questionnaire Results by Item for All Participants – Likert Scale

	The study did not require too much time or effort to participate in.	I would continue using the procedures used in this study to increase running distance or other physical activity.	I run longer distances per week than before participating in this study.	This study was effective in increasing my physical activity levels.	I enjoyed participating in this study.	I liked the procedures used in this study.	I would recommend this study to others.	**Mean**
Adam	4	5	5	5	5	4	4	**4.6**
Mary	3	5	4	5	3	4	4	**4**
Tom	5	5	5	5	5	4	5	**4.9**
Zeke	2	5	5	5	5	4	5	**4.4**
Mean	**3.5**	**5**	**4.75**	**5**	**4.5**	**4**	**4.5**	

Table 2. Social Validity Questionnaire Results by Item for All Participants – Free Response

	How did the procedures influence your running?	Describe how you kept track of your running distance.	What strategies did you use to increase your running distance?	Did you use any other apps or devices to track your running distance?	Where did you engage in running?	Did you engage in other types of physical activity that may have led to running distance?
Adam	Tried to run more when I got goal text	Mile markers on trail	Wake up early, stretching	Typed in miles on iPhone Notes	Trail, treadmill	Shooting hoops, playing tag with niece
Mary	Tried to keep up with goals	Kept track in head, treadmill, iPhone Maps	Increased speed, parking far, increased outdoor activities	iPhone Maps to plan route	Treadmill, parks, outdoor tracks	Speed walking
Tom	Pressure of being watched influenced my activity	Just tried to run further	Put in more effort	No	Outdoors, gym, basketball court	Basketball
Zeke	Knew I had to meet the goal to increase it	Guesstimate how far I went based on time and location	Tried to exercise after work when I could	No	Gym, local park, neighborhood	Basketball

RESULTS

All four participants increased their weekly running distances in the goal-setting phase following baseline. Figure 1 (p. x) shows each participant's weekly running distances across all phases. Adam increased his average weekly running distance from 1.17 mi in baseline to 8.71 mi in goal setting, with a mean of 13.13 miles per week in the last 3 weeks. During goal setting, he achieved his weekly running distance goal on 14 out of 14 weeks (100%) and reached his long-term goal of 14 miles per week in his fourteenth week of goal setting. Mary increased her average weekly running distance from 0.27 mi in baseline to 4.40 mi in goal setting, with an average of 5.26 miles per week in the last 3 weeks. During goal setting, she achieved her weekly running distance goal on 8 out of 11 weeks (72.7%). Tom increased his average weekly running distance from 0.53 mi in baseline to 2.37 mi in goal setting with an average of 0.31 miles per week in the last 3 weeks. During goal setting, he achieved his weekly running distance goal on 3 out of 9 weeks (33.3%). Zeke increased his average weekly running distance from 2.35 mi in baseline to 2.77 mi in goal setting with an average of 1.97 miles per week in the last 3 weeks. During goal setting, he achieved his weekly running distance goal on 3 out of 7 weeks (42.8%).

For participant adherence to the $5 contingency for wearing the Fitbit and uploading data each day, results showed that only one participant, Adam, consistently met the contingency. Adam wore his device and uploaded his data on 113 out of 119 days (94.9%) and met the two-week contingency seven times, earning a total of $35. Mary wore her device and uploaded her data on 90 out of 115 days (78.3%) and met the contingency one time, earning a total of $5. Zeke wore his device and uploaded his data on 89 out of 114 days (78.1%) and met the contingency one time, earning a total of $5. Tom wore his device and uploaded his data on 67 out of 98 days (68.4%) and did not meet the contingency any week, earning $0.

Figure 1. Increasing Weekly Running Distance

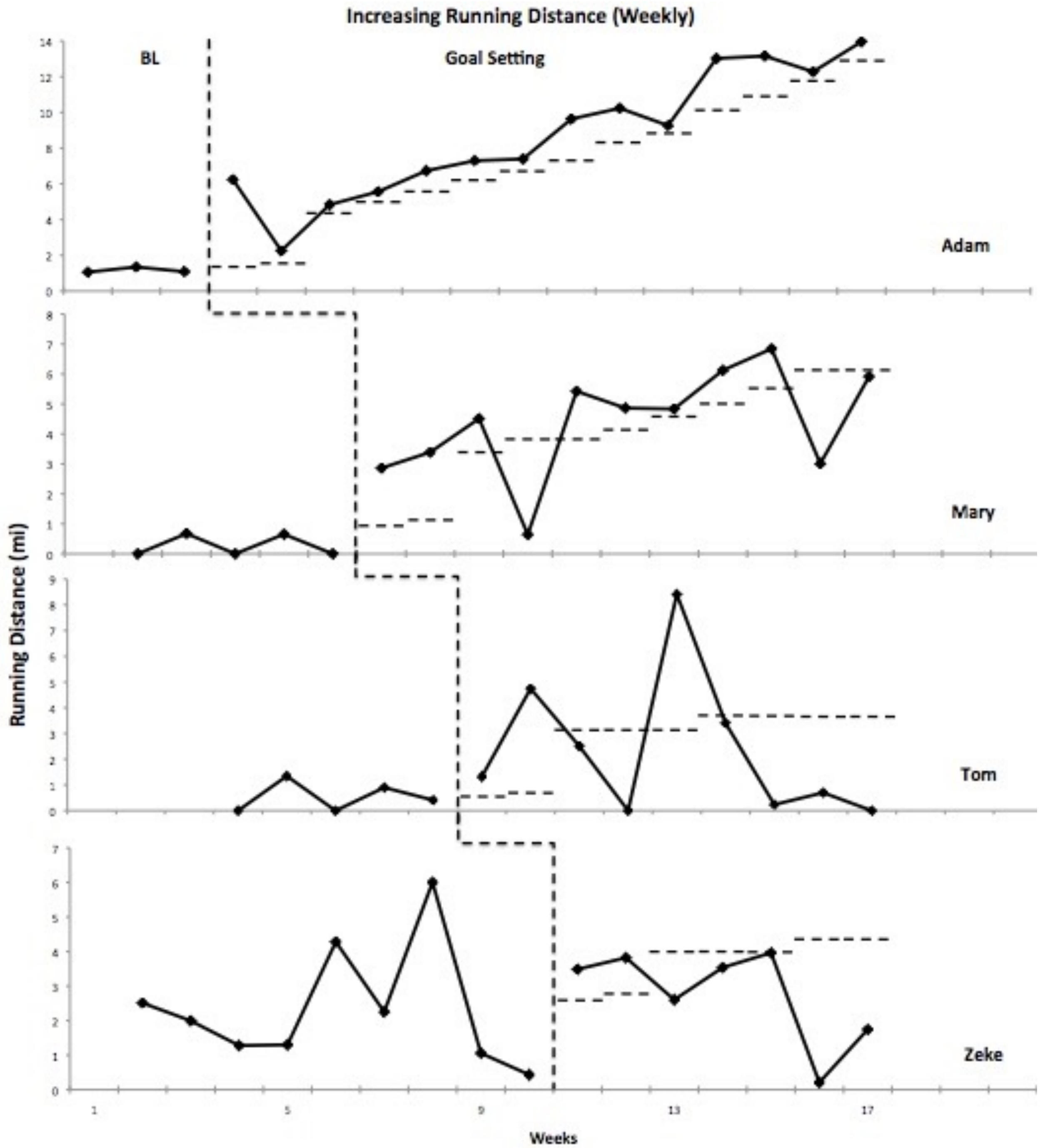

Figure 1 shows the weekly running distance of the four participants across baseline and goal-setting phases. Horizontal lines during intervention represent the goal distance.

DISCUSSION

Based on the results of this study, goal setting and textual feedback without social support was initially effective in increasing the physical activity levels, specifically weekly running distance, for all four healthy adults. As the goal setting phase progressed for each participant, the effects maintained for two of the four participants, Adam and Mary. Participants collectively achieved their goals on 28 of 41 opportunities (68.3%). Furthermore, in four of the instances in which the participants missed a goal, the participants' distances were close to the goal level (e.g., Tom's sixth goal was 3.7 miles and he achieved 3.4 miles, Mary's eleventh goal was 6.1 miles and she achieved 5.9 miles, etc.) suggesting that the goal did influence performance. One participant, Adam, achieved and increased his weekly running distance goal for all 14 opportunities during the goal-setting phase. Mary missed her goal only two times, and she reported in her social validity questionnaire that she was sick with the flu during most of the week of her first miss and did not engage in any exercise at that time. Tom and Zeke missed their goals six and four times, respectively, but still managed to slightly increase their overall weekly running distances during goal setting. Tom withdrew from the study following his ninth week of goal setting due to accepting a full-time job that hindered his ability to wear the device throughout each day and to engage in running often enough to meet his goals. This may explain the sharp decrease in his weekly running distance in his final three weeks of goal setting.

It is not clear what factors may have contributed to Adam's consistent goal achievement. Interestingly, Adam had the highest score on the exercise motivation scale (LCES) with a 6.67

out of 7 and achieved all his goals while Tom had the lowest score with a 5.33 and missed six of his nine goals. More research is needed to evaluate whether motivation scores can predict exercise goal attainment and what other factors might contribute to success. Additionally, Adam reported on his social validity questionnaire that he closely monitored his running distances throughout the week by running mainly at a running trail that contained mile markers and occasionally at the gym on a treadmill when the weather did not allow him to run outdoors. He also mentioned that he paid close attention to his running distances as they approached his goal during the week, suggesting that he was highly motivated to reach his goal each time. Mary also reported running most often on the treadmill and at times on outdoor tracks. All of these settings provided Adam and Mary with resources to track their running distances as they ran even though they did not have access to the Fitbit account data, which may help explain why goal setting was most effective for these two participants. Tom reported playing basketball, working out at the gym, and running outdoors as ways in which he aimed to increase his running distance. He did not report tracking his running distances in a specific way, which may help explain the variability in his data and why he struggled to hit his goals on a consistent basis.

These results are consistent with the findings of other studies that have demonstrated the effectiveness of goal-setting procedures for increasing physical activity (Hayes & Van Camp, 2015; Normand, 2008; Wack et al., 2014). In Wack et al. (2014), three participants who were previously unsuccessful in a daily goal-setting intervention increased their weekly running distances and consistently hit their goals when the intervention was switched to weekly goal setting. This study’s results also show that weekly goal setting itself is an effective intervention for increasing physical activity for some individuals. By removing the social support component included in past studies and only providing neutral feedback to each participant via text message, the effectiveness of goal setting is more clear. In this study, the elimination of social support could have been made even more evident through the use of deception by telling participants that the weekly text message was an automated message sent through a program independently of the researcher. Researchers should continue to evaluate weekly goal setting and daily feedback without social support, as these procedures can potentially be delivered via a smartphone app or a website. The app or website would need to be programmed to increase the goals based on the data as done in this study.

One limitation of this study was that the participants consisted of only four adults, ages 21 to 24 years old. The effects of goal setting on physical activity levels were demonstrated for a relatively small sample size and age range, so future studies may consider using a larger sample size and finding participants with a wider range of ages.

Another limitation was that the Fitbit website tracks daily step count using 5-min intervals. If a participant engaged in running during only part of a 5-min interval, it is likely that he or she did not reach the required 400 steps for that time interval to be counted toward intense steps and running distance. Consequently, some running distance from the beginning or end of participants' runs may not have been counted. To more accurately track running distance, future studies may consider analyzing step counts on a minute-by-minute basis.

A third limitation of this study was that although participants increased their intense steps, the Fitbit does not record the specific topographies of behavior the participants engaged in each time they achieved intense steps. For example, participants may have accrued more than 400 steps in a 5-min period while engaging in various physical activities, such as playing basketball or soccer. Because the study focused on increasing running distance, other physical activities that participants may have engaged in during the intervention may not have been accounted for altogether, such as biking, rollerblading, or working out with weights because the Fitbit would not record steps for these activities. It is also unclear if participants engaged in running for the entire 5-min interval or if they walked at any point in between bursts of running. Based on their self-report from the social validity questionnaires, participants reported engaging in activities such as running on the treadmill, playing basketball, running at outdoor trails and parks, and going for long, brisk walks. Although this provides insight into what types of activities participants engaged in to reach their goals, we cannot determine at which points participants engaged in these activities and if the activities produced intense steps such that running distance was recorded.

Although there are advantages to using a wearable technology like the Fitbit Flex, such as the ability to collect permanent product data without the need for observing the behavior as it occurs each day, this data collection procedure also has its limitations. Because the researcher did not observe the behavior occur, there is no way to confirm that the participant was the person wearing the device at all times. To fix this, future studies may aim to develop a technology that allows the device to recognize who is wearing it, such as a fingerprint reader or some other recognition software. Another limitation of using wearable technology is that participants may misplace or break the device, leading to days in which no data are collected. During her third week of goal setting, Mary lost her Fitbit device when visiting a local theme park. The device had broken by the time it was found, and three days of data were not collected while the researcher waited for a replacement device. Mary still achieved her goal for that week, but this may not have been the case if the replacement device had not come in before the end of the week, which would have affected the results of Mary's weekly goal setting.

Some suggestions for future research studies include direct and systematic replications of this study to assess the generalizability of the results and address the limitations discussed above. Using a larger sample of adult participants with a variable age range would provide a more representative evaluation of the population of interest. Goal setting and textual feedback may also be applied to other populations and ages, such as children and individuals with developmental disabilities, to increase weekly running distance. Also, development of new technologies may lead to more accurate data collection and greater ability for experimental control. Future studies may explore long-term maintenance of the effects of goal setting and textual feedback with minimal social support. Although the procedures were effective in this study up to 12 weeks for one participant, it is unknown how well the procedures would work over many months or years. It is important that behavioral procedures continue to promote physical activity over long periods of time to provide health benefits for individuals. Finally, researchers should strive to establish the relationship between participants' motivation and the success of interventions for promoting physical activity. Researchers should seek to understand: the best way to measure motivation for increasing physical activity, the influence of motivation on success of interventions, ways to increase motivation, and ways to increase physical activity or other health-beneficial behaviors of individuals with low levels of motivation to increase physical activity. This study attempted to enroll participants with high levels of motivation as measured by the LCES, but motivation needs to be better conceptualized, measured, and addressed from a behavior analysis perspective.

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APPENDICES

Appendix A: Locus of Cauasality for Exercise Scale

Locus of Causality for Exercise Scale

Items and Scoring

		Strongly Disagree						Strongly Agree
1	I exercise because I like to rather than because I feel I have to	1	2	3	4	5	6	7
2	Exercising is not something I would necessarily choose to do, rather it is something that I feel I ought to do	1	2	3	4	5	6	7
3	Having to exercise is a bit of a bind but it has to be done	1	2	3	4	5	6	7

Reverse scores on items two and three, then calculate the mean score for the three items. High scores indicate a more internal perceived locus of causality (greater self - determination).

Appendix B: Physical Activity Readiness Questionnaire

PAR-Q

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

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

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

1. Has your doctor ever said that you have a heart condition <u>and</u> that you should only do physical activity recommended by a doctor?

2. Do you feel pain in your chest when you do physical activity?

3. In the past month, have you had chest pain when you were not doing physical activity?

4. Do you lose your balance because of dizziness or do you ever lose consciousness?

5. Do you have a bone or joint problem (for example, back, knee or hip) that could be made worse by a change in your physical activity?

6.Is your doctor currently prescribing drugs (for example, water pills) for your blood pressure or heart condition?

7. Do you know of <u>any other reason</u> why you should not do physical activity?

Appendix C: Inclusion/Exclusion Criteria

INCLUSION/EXCLUSION CRITERIA

This area specifies the criteria that will be looked at when deciding whether or not the participant will be admitted into the study:

- Between the age of 18 and 45 years old.
- Motivation to increase exercise (LCE)
- Good physical health (PAR-Q)
- No risk for health problems or injuries (PAR-Q)
- Ability to communicate with the researcher via text or email
- Will return all materials to the researcher at the conclusion of the study

I, ___________________, have checked each criterion and, therefore, meet the necessary requirements to be considered into this study.

________________________ ______________
Signature Date

________________________ ______________
Witness Date

Appendix D: Social Validity Questionnaire

Social Validity Questionnaire

Question 1: The study did not require too much time or effort to participate in.

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

Question 2: I would continue using the procedures used in this study to increase running distance or other physical activity.

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

Question 3: I run longer distances per week than before participating in this study.

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

Question 4: This study was effective in increasing my physical activity levels.

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

Question 5: I enjoyed participating in this study.

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

Question 6: I liked the procedures used in this study.

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

Question 7: I would recommend this study to others.

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

Appendix D: Social Validity Questionnaire (continued)

Question 8: How did the procedures influence your running?

Question 9: Describe the way in which you kept track of your running distance throughout each week.

Question 10: What strategies did you use to increase your running distance once you started using goal setting?

Question 11: Did you use any other apps or devices to track your running distance or to help you run more?

Question 12: Where did you engage in running during the study? (e.g., treadmill, outdoor track, streets, trails, etc.)

Appendix D: Social Validity Questionnaire (continued)

Question 13: Did you engage in any other types of physical activity that may have led to running distance being recorded on the Fitbit? (e.g., basketball, soccer, softball, etc.)

Additional Comments:

Appendix E: Institutional Review Board Approval Letter

USF UNIVERSITY OF SOUTH FLORIDA

RESEARCH INTEGRITY AND COMPLIANCE
Institutional Review Boards, FWA No. 00001669
12901 Bruce B. Downs Blvd., MDC035 • Tampa, FL 33612-4799
(813) 974-5638 • FAX (813) 974-7091

10/7/2016

Michael Zarate
CFBH-Child and Family Behavioral Health
13610 South Village Dr #111
Tampa, FL 33618

RE: **Expedited Approval for Initial Review**
IRB#: Pro00027839
Title: Evaluating the Effectiveness of Goal Setting and Textual Feedback Using a Wearable Technology for Increasing Running Distance

Study Approval Period: 10/6/2016 to 10/6/2017

Dear Dr. Zarate:

On 10/6/2016, the Institutional Review Board (IRB) reviewed and **APPROVED** the above application and all documents contained within, including those outlined below.

Approved Item(s):
Protocol Document(s):
Zarate-USF IRB Protocol.docx

Consent/Assent Document(s)*:
Zarate-Thesis-InformedConsent.docx.pdf

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

It was the determination of the IRB that your study qualified for expedited review which includes activities that (1) present no more than minimal risk to human subjects, and (2) involve only procedures listed in one or more of the categories outlined below. The IRB may review research through the expedited review procedure authorized by 45CFR46.110 and 21 CFR 56.110. The research proposed in this study is categorized under the following expedited review category:

(7) Research on individual or group characteristics or behavior (including, but not limited to, research on

Appendix E: Institutional Review Board Approval Letter (continued)

perception, cognition, motivation, identity, language, communication, cultural beliefs or practices, and social behavior) or research employing survey, interview, oral history, focus group, program evaluation, human factors evaluation, or quality assurance methodologies.

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

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

Sincerely,

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