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Evaluating the Effectiveness of a Wearable Technology for Increasing Physical Activity

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Evaluating the Effectiveness of a Wearable Technology for Increasing Physical Activity

by

Chris Nieves

A thesis submitted in partial fulfillment of the requirements for the degree of Master of Arts in Applied Behavior Analysis Department of Child and Family Studies College of Behavioral and Community Sciences University of South Florida

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Keywords: Sports, Aerobic Fitness, Caloric Expenditure, Goal Setting, Self-Monitoring, Nike™ FuelBand

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Abstract

Obesity in America has grown widespread over the past decade and is a significant social issue that affects many families. Identifying interventions that are not only effective in the natural environment but are easy to implement are ideal for helping individuals engage in more fitness related activities. The purpose of this study was to evaluate the effectiveness of the Nike™ FuelBand for increasing physical activity in 3 adults. Additionally, a goal setting procedure was used to test if it enhanced the effects of the Nike™ FuelBand. Three measures were collected as part of the study, Nike™ Fuel, daily steps, and caloric expenditure. The Nike™ FuelBand was found to be effective at increasing all participants Nike™ Fuel score, daily steps, and caloric expenditure daily average from baseline to intervention phase. The goal setting procedure was found to be effective at increasing Nike™ Fuel point score, daily steps, and caloric expenditure daily average scores for two of three participants.

Keywords: sports, aerobic fitness, caloric expenditure, goal setting, self-monitoring, Nike™ FuelBand
Chapter One:

Introduction

In the United States, obesity has become an epidemic that affects all ages, races, and genders. When speaking strictly about the adults in America, 35.7% of this population is overweight or obese (Centers for Disease Control and Prevention, 2013). When an individual is overweight or obese, this increases the chances of developing Type 2 diabetes, heart disease, stroke, and certain preventable cancers (Centers for Disease Control and Prevention, 2013). Given all of the negative side effects associated with obesity, this creates a socially significant issue that needs to be addressed in a systematic manner in order for behavior change to take place.

One main factor that contributes to the increase in obesity or being overweight is lack of physical activity. It is recommended that an adult engage in at least 150 min of moderate intensity exercise a week (U.S. Department of Health and Human Services, 2008). To promote individuals to engage in physical activity, several studies have applied the use of various behavioral interventions. The behavior analytic procedures that were most common across the literature at increasing physical activity were self-monitoring, feedback, goal setting, and a majority of these interventions work in unison with other behavioral procedures to form a treatment package (Brobst & Ward, 2002; Critchfield & Vargas, 1991; Martin, Thompson, & Regehr, 2004; Mckenzie & Rushall, 1974; Ward & Carnes, 2002).

Self-monitoring has been used in a variety of settings and contexts to help promote behavior change (Critchfield & Vargas, 1991). Self-monitoring consists of recording one’s own
behavior and writing down the occurrence or non-occurrence of a particular behavior. The act of self-recording the target behavior also allows the individual to see his or her performance on a more immediate basis and allows for the individual to modify this behavior as is necessary (Cooper, Heron, & Heward, 2007). Critchfield and Vargas (1991) evaluated the effects of a self-monitoring procedure on the number of laps swam by a high school swimmer during regularly scheduled practice sessions. The study used a multiple baseline across subjects design and results showed that there was an increase from baseline to intervention phases when self-recording was implemented.

Mckenzie and Rushall (1974) evaluated self-recording in the swimming environment. This study used a multiple baseline design with two conditions that looked at the public posting of attendance rates by swimmers as well as the number of laps swam during regularly scheduled practices. The results showed that the use of a self-monitoring treatment package for swimmers increased their attendance and work rates at practice.

Many researchers have found that goal setting can be used in a variety of settings and complex community environments (Brobst & Ward, 2002; Martin et al., 2004; Ward & Carnes, 2002). When applying the goal-setting procedure to sports and fitness, the individual sets a specific criterion or performance standard that can be worked toward to contact reinforcement (Locke & Latham, 1990). This criterion is then gradual raised so that a new goal can be worked towards and the individual can eventually contact the reinforcement associated with completing the goal. Goal setting can also be coupled with a variety of other procedures that increase its ultimate effectiveness (Brobst & Ward, 2002; Martin, et al., 2004; Normand, 2008; VanWormer, 2004; Ward & Carnes, 2002).
The most common versions of this intervention were goal setting with public posting, goal setting and feedback, and goal setting as part of a treatment package (Martin et al., 2004). Goal setting and public posting is when the criterion that is established is paired with the revealing of this information so that peers and the individual engaging in the behavior can view it. Researchers have found that applying goal-setting procedures to increase the physical activity of individuals was effective (Brobst & Ward, 2002; Ward & Carnes, 2002). Brobst and Ward (2002) examined the effects of an intervention package that incorporated goal setting and public posting for a high school girls soccer team. This study used a multiple baseline across behaviors design that studied three independent behaviors that were deemed integral to the game of soccer (e.g. movement with the ball, movement during restarts, and movement after the player passed the ball). Results showed that there were increases in all three behaviors of interest when the goal setting intervention was introduced into the environment.

Ward and Carnes (2002) used the same goal setting and public posting procedure in the football setting. The study used a multiple baseline design across behaviors to target football skills of linebackers in a scrimmage setting. The dependent variables were the number of reads, drops, and tackles that were exhibited by each of the participants. The researchers found that when the intervention was implemented, all behaviors increased from baseline.

Some of the most common interventions that were effective at enhancing physical activity involved multi component packages that used elements of self-monitoring, feedback, and goal setting (Normand, 2008; VanWormer, 2004). These packages also utilized a technology component that provided the user with a way to self-monitor and receive feedback. VanWormer (2004) used pedometers to increase participants’ physical activity and found that the use of self-monitoring, feedback, and goal setting was effective at increasing participants’ step count. Three
overweight adults wore pedometers for a 10-week period to assess their physical activity. During baseline, participants wore pedometers with tamper proof tape placed around the pedometer’s display so that participants did not receive any feedback from the devices. During the first intervention phase, the tape was removed and participants were told to record on a data sheet their steps every evening before they went to sleep. The next phase of the study was similar to the first phase, except an e-counseling component was added. This e-counseling component consisted of the researcher meeting with the participant, going over the step count for the week, and establishing a weekly goal as well as providing praise. The results showed that the use of self-monitoring was effective at increasing the step count of all participants from baseline. In addition, the e-counseling component was found to be effective only at increasing the step count for one of the participants. This study suggests that using technology to deliver an intervention package of self-monitoring, feedback, and goal setting was beneficial at increasing the physical activity for all the participants in the study.

Normand (2008) also utilized technology to deliver a treatment package of self-monitoring, feedback, and goal setting. This study looked at increasing physical activity for four adults using pedometers. Baseline and intervention phases were the same procedure as the VanWormer (2004) study. Feedback in the form of praise was provided to each participant for meeting weekly goals and corrective feedback was provided to each participant for not meeting weekly goals. Participants also had weekly meetings with the researcher to go over the data for the week and to look at the graphical displays of their data to see their progress. Results showed that the intervention increased physical activity for three of the four participants in the study. This study suggests that the use of technology to deliver a multi-component treatment package was effective.
Recently, several new technologies have been developed and have been mass marketed to individuals who are interested in increasing physical activity and monitoring their activity levels (Crowley-Koch & Van Houten, 2013). One of these new technologies that has automated self-monitoring, feedback, and goal setting is the Nike™ FuelBand. The FuelBand uses a 3-axis accelerometer to detect and measure movement in the user, which is converted into Nike™ Fuel, steps, and caloric expenditure. The Nike™ Fuel metric was designed to quantify the energy needed to perform a physical movement regardless of the sex, age, or fitness level of the user (“Nike™+ FuelBand: User guide,” 2014). The Nike™ Fuel measure is based on a user oxygen uptake scores during active movements then converted into the metabolic equivalent of a task (M.E.T.) index. This allows users to compare Nike™ Fuel scores across a wide range of sports and leisure activities. Nike™ Fuel is displayed on the outside of the wearable wristband and an individual can access this feedback with the press of a button. Instead of only evaluating step count as in previous studies, the Nike™ FuelBand tracks movement used for a variety of sports and leisure activities that would not otherwise be able to be calculated and compared (“Nike™+ FuelBand: User guide,” 2014).

A couple studies have evaluated the effectiveness of the Nike™ FuelBand to accurately track physical activity (Caesar, 2012; Guo, Li, Kankanhalli, & Brown, 2013). Caesar (2012) evaluated three triaxial accelerometers (e.g. Nike™ FuelBand, Fitbit, and GT3X+) to test if the devices accurately assessed energy expenditure. The study found that the Nike™ FuelBand was more accurate at estimating energy expenditure when it came to sports-oriented activities that involved arm movements. Guo et al. (2013) evaluated several activity monitoring devices that are currently on the market for accuracy when recording step count (e.g. Nike™ FuelBand and Fitbit™). The study found that the Nike™ FuelBand was less accurate at predicting step count.
than the Fitbit™ device. The limitation of these monitoring devices to accurately track physical activity has to do with current accelerometers design and the position of the device on the body (e.g., wrist-worn and hip-worn). While devices that are wrist-worn (e.g. Nike™ FuelBand) are more effective at tracking movements above the waist, they are not as effective at tracking movements below the waist. Hip-worn devices (e.g. Fitbit™) are more effective at tracking movements below the waist but are not as effective at tracking movements above the waist (Caesar, 2012; Guo et al., 2013).

Although several studies have evaluated the accuracy of the Nike™ FuelBand, no studies have been conducted that use the Nike™ FuelBand as an intervention to increase physical activity. And, studies that have used physical activity monitoring devices have been limited to using step count as the main dependent variable although some individuals may engage in a variety of physical activity other than walking. The purpose of this study was to evaluate the effectiveness of the Nike™ FuelBand, a wearable technology meant to increase all types of physical activity. Additionally, the use of goal setting was added to see if it enhanced the effects of the Nike™ FuelBand.
Chapter Two:

Method

Participants and Setting

Three healthy adults participated in this study. Fred, Ryan, and Nancy were all recruited using flyers (see Appendix A) that were posted around a local gym. Fred was a 26 year old full time college student who worked as a teachers’ aid at a local high school. Ryan was a 22 year old recent college graduate who worked as a social worker in the area. Nancy was a 25 year old full time teacher at a local elementary school. All participants expressed an interest in increasing the amount of physical activity that they currently engaged in. The recruitment flyer let the participants know how to contact the researcher, the length of the study, and the inclusion/exclusion criteria for participating. Prior to acceptance into the study, participants met with the principal investigator to review the inclusion/exclusion criteria (Appendix E) and the informed consent. The researcher gave each participant an information sheet (Appendix C) that explained the outline of the study and answered any questions regarding the procedure for the study. The potential participant was given a week to decide if he or she wanted to take part in the study. Once he or she accepted, the principal investigator had the participant fill out the inclusion/exclusion criteria and informed consent. Each participate then filled out the Physical Activity Readiness Questionnaire (see Appendix B) (PAR-Q; Thomas, Reading, & Shephard, 1992) before participating to assess certain health risk factors associated with exercise and fitness. In order to participate in the study, all participants had to answer no to all questions on the PAR-Q.
The study took place across all of the participants’ natural settings in which they spent time on a daily basis (e.g. work, school, gym, and house).

**Materials**

At the start of the study, participants received a packet with all of the information about the study (see Appendix C) and weekly data sheets (see Appendix D). Participants also received the Nike™ FuelBand and charging cable. All participants also assured the researcher that they had access to a laptop or smartphone that was capable of running the Nike™ FuelBand application.

**Data Collection**

The main dependent variable in the study was Nike™ Fuel. Nike™ Fuel was defined as all movements recorded by the Nike™ FuelBand that resulted in a score increase in the Nike™ Fuel metric. Two secondary dependent variables were also measured, caloric expenditure and step count. Caloric expenditure and step count were defined as any movement that resulted in an increase in the metric on the Nike™ FuelBand. Nike™ Fuel, caloric expenditure, and step count were collected as a permanent product via the Nike™+ website.

During the study, the principal investigator met weekly with participants to collect data and charge the Nike™ FuelBands for the participants. Researchers plugged in the Nike™ FuelBands to their computers and synced the participants’ data to the website. After baseline, all participants synced their Nike™ FuelBands to their smart phone or computer and imported their data automatically into their Nike™+ account. During the goal-setting intervention, all participants recorded their Nike™ Fuel, steps, and caloric expenditure on their data sheet (see Appendix D). At the end of the week, the researcher and participant met and reviewed their data (“Nike™+ FuelBand: User guide,” 2014).
When collecting data from participants, two rules were used in order for a data point to be counted. One, all decisions to move each participant through the different phases was based on the current data set at that time and subsequent days were not counted until the researcher met with the participant. Two, the participant had to wear the Nike™ FuelBand for a minimum of 9 hr for that day in order for it to counted as part of the study.

**Reliability and Validity**

Prior to the onset of the study, researchers tested the reliability and validity of the Nike™ FuelBand with regard to its Nike™ Fuel and pedometer metrics. Nike™ Fuel was tested for reliability by placing two Nike™ FuelBands on the same arm of a person and having the individual engage in 2 min of movement. The Nike™ Fuel metric was then recorded for both Nike™ FuelBands and the average agreement was calculated. The validity of the pedometer function for the Nike™ FuelBand was tested by placing the device on a person for 2 min while he engaged in different topographies of active behavior on a treadmill. The principal investigator counted the steps and compared scores against the steps recorded by the Nike™ FuelBand. The agreement between the metric recorded by the device and the observer was then calculated. Under each of these conditions, two sessions were conducted to assess the reliability and validity of the Nike™ FuelBand (Ek & Miltenberger; 2012). Average agreement for both reliability checks for Nike™ Fuel was 90% and 98% respectively. Average agreement for both validity checks for the step count metric were 73% and 83%.

**Interobserver Agreement (IOA)**

Two observers (the principal investigator and research assistant) y independently recorded the date, Nike™ Fuel, step count, and caloric expenditure metric from the Nike™ website. The date, Nike™ Fuel, step count, and caloric expenditure score needed to be exact for
an agreement to take place. IOA was calculated by taking the number of agreements divided by the number of opportunities and then multiplied by 100. IOA was assessed for 100% of sessions across all participants. IOA was 100% across baseline conditions, 95% across the Nike™ FuelBand intervention phase, and 100% across the goal-setting phase.

**Experimental Design**

A non-concurrent multiple-baseline across participants design was used to test the effects of the Nike™ FuelBand at increasing physical activity in three sedentary adults. A changing criterion design was used during the last phase to evaluate whether goal setting increased physical activity.

**Procedure**

Following acceptance into the study, participants met with researchers to receive the Nike™ FuelBand and information about the study. The researcher showed the participant how to correctly place, charge, and setup the Nike™ FuelBand (“Nike™+ FuelBand: User guide,” 2014). The principal investigator created an account for each participant on the Nike™+ website and helped install the mobile Nike™ FuelBand application. Participants gained access to their login information to the Nike™+ website when baseline was completed.

**Baseline.** Collection of baseline data occurred immediately after the completion of the first meeting when participants received their Nike™ FuelBand. During baseline, all feedback that the Nike™ FuelBand provided (e.g. Nike™ Fuel, caloric expenditure, and steps taken) was blocked so that participants could not access any of the feedback. The feedback was blocked on the FuelBand by applying tamper-evident tape around the digital display. During the baseline phase, participants were told to engage in physical activity as they typically would until researchers instructed them otherwise.
Nike™ FuelBand. During this intervention phase, the adhesive tape on the digital display for the Nike™ FuelBand was removed and participants gained access to all of the features of the device. Participants were given their daily average Nike™ Fuel score during baseline and the login information for the Nike™+ website (see Appendix F) and smartphone application. Once the participant logged into the account, he or she was taken to the Nike™+ website dashboard (see Appendix G). In the dashboard, participants looked at their current physical activity for that day (e.g. Nike™ Fuel, step count, caloric expenditure), setup goals, and interacted with the social media components of the Nike™+ website and application. From the dashboard, participants also accessed the activity tab (see Appendix H). The activity tab allowed the user to look at physical activity across time (e.g. weeks, months, and years) and displayed averages on their performance. The principal investigator instructed participants to wear the devices and use any of the features with the website or application that they would like to (“Nike™+ FuelBand: User guide,” 2014). Researchers met with participants weekly to collect data and review their data from the previous week.

Goal Setting. Once the participants’ Nike™ Fuel score remained stable during the first intervention phase, subjects that averaged less than 10,000 steps per day were asked if they wanted to enter the goal-setting phase. The goal-setting intervention involved manually setting a Nike™ Fuel goal via the Nike™ FuelBand application on the participants’ smartphone or the Nike™+ website. The first goal was calculated by averaging the daily Nike™ Fuel score during the Nike™ FuelBand intervention phase. Participants that averaged less than 5,000 Nike™ Fuel points per day during the Nike™ FuelBand phase, set a goal that was 20% above intervention average. Participants that averaged over 5,000 Nike™ Fuel points per day during the Nike™ FuelBand phase, set a goal that was 10% above intervention average. If the participant achieved
5 out of 7 days at the criterion level for their Nike™ Fuel goal, the researcher asked the participant if he or she would like increase the goal by 10% or 20% for the following week. If the participant did not achieve the daily goal for 5 out of the 7 days for that week, the goal would stay the same for the following week before the participant was allowed to increase the goal. The researcher met with participants every week and showed them the weekly graphs via the Nike™+ website, provided praise for meeting their goals, and setting new goals. Goals were set based on the principal investigator original data set. All participants were given the option to enter the goal setting phase of the study and all three chose to do so.

**Social Validity**

A social validity questionnaire (see Appendix I) was administered at the end of the study that assessed the acceptability of the intervention for each individual. The social validity questionnaire used a 1-5 Likert-type scale (1=strongly disagree; 2=disagree; 3=neutral; 4=agree; 5=strongly agree) with questions to assess whether participants enjoyed the study, were satisfied with the results of the study, whether they engage in more physical activity now than before the study started, whether it was easy to use the Nike™ FuelBand, and if they will continue exercising after the conclusion of the study.
Chapter Three:

Results

Table 1. displays the average scores for Nike™ Fuel, steps counted, and caloric expenditure for Fred, Ryan, and Nancy across each phase. Averages were calculated by adding up the daily amount of Nike™ Fuel, steps counted, and caloric expenditure from each phase and dividing it by the number of days in that phase. Both Nancy and Ryan increased their Nike™ Fuel, caloric expenditure, steps, from the baseline phase to the Nike™ Fuelband phase and from the Nike™ Fuelband phase to the goal setting phase. However, Fred only increased his Nike™ Fuel, caloric expenditure and steps, from the baseline phase to the Nike™ Fuelband phase but showed a small decrease in all metrics after entering the goal-setting phase. From baseline to intervention, Ryan improved his Nike™ Fuel score by 7%, his step count by 26%, and his caloric expenditure by 8%. From the Nike™ FuelBand intervention to goal setting, Ryan’s average Nike™ Fuel score increased by 31%, step count by 15%, and caloric expenditure by 29%. From baseline to intervention, Nancy increased her Nike™ Fuel score by 13%, step count by 28%, and her caloric expenditure by 14%. After the goal setting component, Nancy’s Nike™ Fuel score increased by 15%, step count by 20%, and caloric expenditure by 14%. From baseline to intervention, Fred improved his Nike™ Fuel score by 46%, his step count by 21%, and his caloric expenditure by 15%. From the Nike™ FuelBand intervention to goal setting, Fred’s Nike™ Fuel score average decreased by 13%, step count by 10%, and his caloric expenditure by 15%.
Figure 1 displays the Nike™ Fuel scores for Fred, Ryan, and Nancy across all phases in the study. During baseline, all participants’ Nike™ Fuel was highly variable throughout the phase and then stabilized prior to intervention. Following baseline, Nike™ Fuel increased in level for Fred, Ryan, and Nancy but still had some degree of variability. During the goal setting intervention, only Ryan met his weekly goal and increased it for the following week. Both Nancy and Fred either stayed at or lowered their goal after entering the goal setting phase. Ryan met his goal on 15 out of 21 days (71%), Nancy met her goal 12 out of 28 days (43%), and Fred met his goal 9 out of 49 days (18%). Figure 2 shows step counts and Figure 3 shows caloric expenditure for all participants. Similar results were observed for both metrics with respect to variability in the data from day to day.

Social validity results are displayed in Table 2. Scores from social validity assessed the participants’ satisfaction with the results, their participation in the study, whether they were more physical activity now than before the study, ease of use for the Nike™ FuelBand, continued exercising after the conclusion of the study, and whether they would recommend using the Nike™ FuelBand to others. Fred, Ryan, and Nancy social validity scores were 3.5, 4.6, and 4.
Tables and Figures

Table 1

*Average Scores for Nike™ Fuel, Step count, and Caloric Expenditure for all participants across each phase. The percent change between phases for all metrics is also shown.*

<table>
<thead>
<tr>
<th>Participant</th>
<th>Metrics</th>
<th>BL Avg</th>
<th>% Change</th>
<th>Nike™ FuelBand Avg.</th>
<th>% Change</th>
<th>Goal Setting Avg.</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fred</td>
<td>Nike™ Fuel</td>
<td>2068</td>
<td>+46%</td>
<td>3026</td>
<td>-13%</td>
<td>2635</td>
</tr>
<tr>
<td></td>
<td>Step Count</td>
<td>6074</td>
<td>+21%</td>
<td>7322</td>
<td>-10%</td>
<td>6591</td>
</tr>
<tr>
<td></td>
<td>Caloric Exp.</td>
<td>674</td>
<td>+15%</td>
<td>777</td>
<td>-15%</td>
<td>663</td>
</tr>
<tr>
<td>Ryan</td>
<td>Nike™ Fuel</td>
<td>4160</td>
<td>+7%</td>
<td>4461</td>
<td>+31%</td>
<td>5833</td>
</tr>
<tr>
<td></td>
<td>Step Count</td>
<td>7689</td>
<td>+26%</td>
<td>9703</td>
<td>+15%</td>
<td>11141</td>
</tr>
<tr>
<td></td>
<td>Caloric Exp.</td>
<td>1090</td>
<td>+8%</td>
<td>1181</td>
<td>+29%</td>
<td>1528</td>
</tr>
<tr>
<td>Nancy</td>
<td>Nike™ Fuel</td>
<td>1885</td>
<td>+13%</td>
<td>2127</td>
<td>+15%</td>
<td>2445</td>
</tr>
<tr>
<td></td>
<td>Step Count</td>
<td>5876</td>
<td>+28%</td>
<td>7519</td>
<td>+20%</td>
<td>9058</td>
</tr>
<tr>
<td></td>
<td>Caloric Exp.</td>
<td>437</td>
<td>+14%</td>
<td>497</td>
<td>+14%</td>
<td>568</td>
</tr>
</tbody>
</table>

*Notes. All numbers were rounded up to the nearest whole number.*
Table 2

Results from Participants’ Social Validity Questionnaire

<table>
<thead>
<tr>
<th></th>
<th>I enjoyed participating in this study</th>
<th>I am happy with the overall results I achieved</th>
<th>I engage in more physical activity now than before the study</th>
<th>I believe the study was effective at increasing my physical activity and reducing weight</th>
<th>I find the Nike™ FuelBand easy to use</th>
<th>I would like to continue using the Nike™ FuelBand and recommend it to others.</th>
<th>Avg. Rating</th>
</tr>
</thead>
<tbody>
<tr>
<td>Fred</td>
<td>4</td>
<td>3</td>
<td>3</td>
<td>3</td>
<td>4</td>
<td>4</td>
<td>3.5</td>
</tr>
<tr>
<td>Ryan</td>
<td>5</td>
<td>5</td>
<td>5</td>
<td>3</td>
<td>5</td>
<td>5</td>
<td>4.6</td>
</tr>
<tr>
<td>Nancy</td>
<td>4</td>
<td>4</td>
<td>3</td>
<td>4</td>
<td>5</td>
<td>4</td>
<td>4</td>
</tr>
</tbody>
</table>

Notes. All numbers were rounded up to the nearest decimal place.
Figure 1. Nike™ Fuel points during baseline and intervention phases for all participants. After baseline, the Nike™ FuelBand was implemented and then a goal setting procedure was implemented for all participants. Red lines represent the mean lines for that phase.
Figure 2. Steps counted during baseline and intervention phases for all participants. After baseline, the Nike™ FuelBand was implemented and then a goal setting procedure was implemented for all participants. Red lines represent the mean lines for that phase.
Figure 3: Caloric expenditure during baseline and intervention phases for all participants. After baseline, the Nike™ FuelBand was implemented and then a goal setting procedure was implemented for all participants. Red lines represent the mean lines for that phase.
Chapter Four:

Discussion

This study evaluated the effects of the Nike™ FuelBand and goal setting at improving physical activity in three sedentary adults. From baseline to the Nike™ FuelBand phase, Fred, Ryan, and Nancy all increased their Nike™ Fuel score, steps counted, and caloric expenditure metrics. From the Nike™ FuelBand intervention to goal setting, only Ryan and Nancy increased their Nike™ Fuel score, steps counted, and caloric expenditure metrics. Results of the study may suggest that the use of technology to deliver a treatment package to increase physical activity may be effective for some individuals.

Results were similar to other studies that have used technology to deliver a treatment package to increase physical activity in participants (Normand, 2008; VanWormer, 2004). For each phase in the study, variability was present for all participants except for Ryan during the goal-setting phase. In goal setting, Ryan’s Nike™ Fuel goal was reached and increased three times throughout the phase. Variability in the study could be attributed to the type of data that was collected that was based around daily physical activity. For each participant, daily physical activity could fluctuate depending on the amount of free time that was available and competing contingencies. Fred was a full time student who started baseline and the Nike™ FuelBand intervention during the summer when he was not taking classes. When Fred entered the goal-setting phase of the study, he had just started his fall semester back at school. When there was a decrease in free time and a competing contingency of schoolwork present, Fred may have been less likely to engage in physical activity throughout the day. Ryan’s variability in the baseline
condition may have in part due to reactivity during the start of the study when he received the Nike™ FuelBand.

The goal-setting intervention for increasing physical activity was only effective for one out of three participants. Only Ryan consistently hit his goal 5 out of 7 days for the week and increased the criterion. Goals were based on participants’ average during the Nike™ FuelBand intervention and increased by 20% for the first goal. Both Fred and Nancy were unable to hit this weekly goal and increase it throughout the entire goal setting intervention. Future studies should look at giving participants more choice in selecting their goals as well as increasing their goals by different percentages.

Although this study may suggest that the Nike™ FuelBand was effective at increasing participants’ physical activity, several limitations were still present. One limitation was adherence to wearing the Nike™ FuelBand throughout the entirety of the day and remembering to put on the Nike™ FuelBand in the morning. Numerous data points were excluded for participants that did not wear the band for 9 hours of the day. Future studies should look at how to increase adherence to wearing the wearable technology so that individuals can accurately track their physical activity.

In addition, this study only evaluated the Nike™ FuelBand with three participants that fell within the 20 to 29 age range. Future studies should look at increasing the number of participants to test the effectiveness of the Nike™ FuelBand and goal-setting intervention. Also, future studies should use different age populations to test whether the Nike™ FuelBand would have the same effect on physical activity. Long-term data should be evaluated in future studies to see if the increases in Nike™ Fuel maintain over long periods of time.
Future research should evaluate having the participants’ use all of the components of the website (or a component analysis of the features) including connecting to social media sites such as Facebook™, creating friend groups, move reminders, and looking at breakdowns of graphical data via the website. Although the participants in this study had access to those features, during the weekly meetings participants indicated that they rarely or never used these features. Some of these features might enhance motivation to increase Nike™ Fuel points and should be evaluated.

In closing, the present study evaluated the effectiveness of the Nike™ FuelBand for increasing physical activity for three young adults. Additionally, a goal-setting procedure was used to test if it enhanced the effects of the Nike™ FuelBand. Overall, the Nike™ FuelBand was found to be effective at increasing all participants Nike™ Fuel score, daily steps, and caloric expenditure daily average from baseline to Nike™ FuelBand intervention phase. And, the goal setting procedure was found to be effective at increasing the Nike™ Fuel point score, daily steps, and caloric expenditure daily average for two of the participants.
References


Appendices
Appendix A: Recruitment Flyer

Looking to increase the amount of physical activity you engage in?
Participate in a Research Opportunity

Purpose: Evaluate the effectiveness of a wearable technology for increasing exercise behavior
Participants: Individuals between the ages of 18-50 looking to increase their physical activity
In order to participate you must:

- Live in the Tampa Bay area
- Be willing to meet weekly via Skype and/or in person (30 mins)
- Be in good health (i.e., no ongoing medical condition that could worsen with physical activity)
Appendix B: Physical Activity Readiness Questionnaire (PAR-Q)

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 and 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 any other reason why you should not do physical activity?
Appendix C: Information About Study

Information About the Study

PURPOSE: The purpose of this study is to evaluate the effectiveness of the Nike™ FuelBand, a wearable technology meant to increase physical activity. Additionally, the use of a goal setting procedure will be used to see if it enhances the effects of the FuelBand.

Rules:
• You must be willing to increase your physical activity.
• You must be willing to continue with this study for approximately 12-16 weeks.
• You must be willing to send data to the experimenter.
• You must be willing to meet with experimenter for weekly meetings.
• In the case of vacation, sickness, or emergency you must call the experimenter prior to the meeting in order to determine an alternative plan.
• You must return any equipment at the end of the study or if you drop from the study.
Appendix D: Data Sheet

<table>
<thead>
<tr>
<th></th>
<th>Fuel Points</th>
<th>Steps</th>
<th>Caloric Expenditure</th>
<th>Weekly Goal-Setting</th>
</tr>
</thead>
<tbody>
<tr>
<td>MONDAY</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>TUESDAY</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>WEDNESDAY</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>THURSDAY</td>
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<tr>
<td>FRIDAY</td>
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<tr>
<td>SATURDAY</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td>SUNDAY</td>
<td></td>
<td></td>
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<td></td>
</tr>
</tbody>
</table>
Appendix E: Inclusion/Exclusion Criteria

INCLUSION/EXCLUSION CRITERIA

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

- Good physical health (PAR-Q)
- No risk for health problems or injuries (PAR-Q)
- Motivation to increase physical activity
- Can meet at least once a week for approximately 10-15 minutes
- Engage in less than 150 mins of moderate of physical activity a week
- Plan to continue this study for as long as necessary to meet a long-term goal
- Own a smartphone and/or computer that that can access the Nike™ FuelBand application
- Can promise to return all materials to the experimenter upon study termination

I ___________________ have checked each box, and therefore met the necessary requirements to be considered into the study.

__________________________________________  __________________________
Signature                                       Date

__________________________________________  __________________________
Witness                                         Date
Appendix F: Login
Appendix G: Dashboard
Appendix H: Activity
Appendix I: Activity

Social Validity Questionnaire

1. I enjoyed participating in this study:

<table>
<thead>
<tr>
<th>Strongly Disagree</th>
<th>Disagree</th>
<th>Neutral</th>
<th>Agree</th>
<th>Strongly Agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
</tbody>
</table>

Why: __________________________________________________________

2. I am happy with the overall results that I have achieved as part of the study:

<table>
<thead>
<tr>
<th>Strongly Disagree</th>
<th>Disagree</th>
<th>Neutral</th>
<th>Agree</th>
<th>Strongly Agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
</tbody>
</table>

Why: __________________________________________________________

3. I engage in more physical activity now than before participating in this study.

<table>
<thead>
<tr>
<th>Strongly Disagree</th>
<th>Disagree</th>
<th>Neutral</th>
<th>Agree</th>
<th>Strongly Agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
</tbody>
</table>

4. I believe that this study was effective at increasing my physical activity and reducing my weight.

<table>
<thead>
<tr>
<th>Strongly Disagree</th>
<th>Disagree</th>
<th>Neutral</th>
<th>Agree</th>
<th>Strongly Agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
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<td>4</td>
<td>5</td>
</tr>
</tbody>
</table>

5. I find the Nike™ FuelBand easy to use:

<table>
<thead>
<tr>
<th>Strongly Disagree</th>
<th>Disagree</th>
<th>Neutral</th>
<th>Agree</th>
<th>Strongly Agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
</tbody>
</table>

6. I would like to continue to use the Nike™ FuelBand and recommend it to others:

<table>
<thead>
<tr>
<th>Strongly Disagree</th>
<th>Disagree</th>
<th>Neutral</th>
<th>Agree</th>
<th>Strongly Agree</th>
</tr>
</thead>
<tbody>
<tr>
<td>1</td>
<td>2</td>
<td>3</td>
<td>4</td>
<td>5</td>
</tr>
</tbody>
</table>
7. What aspects of the Nike™ FuelBand did you like?

8. What aspects of the Nike™ FuelBand did you not like?

9. Which metric did you find more motivating for you (i.e. Nike™ Fuel, Steps, or Caloric Expenditure)? Why?
Appendix J: IRB Approval Letter

April 9, 2014

Christopher Nieves
ABA-Applied Behavior Analysis
Tampa, FL 33612

RE: Expedited Approval for Initial Review
IRB#: Pro00016369
Title: Evaluating the Effectiveness of a Wearable Technology for Increasing Physical Activity


Dear Dr. Nieves:

On 4/9/2014, the Institutional Review Board (IRB) reviewed and APPROVED the above application and all documents outlined below.

Approved Item(s):
Protocol Document(s):
Thesis Proposal

Consent/Assent Document(s)*:
Informed Consent.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:

(6) Collection of data from voice, video, digital, or image recordings made for research purposes.
(7) Research on individual or group characteristics or behavior (including, but not limited to, research on perception, cognition, motivation, identity, language, communication, cultural beliefs or practices, and social behavior) or research employing survey, interview, oral history, focus group, program evaluation, human factors evaluation, or quality assurance methodologies.

As the principal investigator of this study, it is your responsibility to conduct this study in accordance with IRB policies and procedures and as approved by the IRB. Any changes to the approved research must be submitted to the IRB for review and approval by an amendment.

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