# Combating Obesity Trends in Teenagers Through Persuasive Mobile Technology

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Throughout the last decade, there has been an alarming increase in obesity prevalence among adults and teens throughout the world. Obesity has been found to increase the risk of developing diabetes, cardiovascular diseases, and some cancers. Due to the many health risks associated with obesity, an increase in prevalence has also pressured health care systems and the finances of the individual. Our research proposes to decrease obesity prevalence in adults by motivating teens to become or continue being physically active so that they can continue these healthy lifestyles as adults. Our goal is to encourage long term adoption of physically active behaviors by introducing a motivating application running on a mobile device. We use the Technology Acceptance Model, the Theory of Planned Behavior, the Theory of Meaning Behavior, and the Big 5 Personality Theory to guide our design.

This summer's research was a pilot study in which we built a prototype system for the iPhone/iPod Touch platform, and conducted a user study with teenagers, the target users for our application. The feedback from the user study will help us evaluate how effective the system is in motivating physical activity, which kinds of games the teens did and didn't like, and how to make the application more fun. These results will be used to guide the next iteration of the system, which will be built and tested in a follow-up, long-term study.

## Introduction

Obesity is a worldwide problem largely influenced by sedentary lifestyles and unhealthy diets. Obesity has been found to increase the risks of developing heart disease, diabetes, high blood pressure, and some cancers [1]. Not only does obesity affect an individual's health but it also puts pressure on health care systems. Overweight and obesity cost the United States as high as 78.5 billion dollars in 1998 in medical expenses alone. Out of these costs, it was estimated that about half of the amount was covered by Medicaid or Medicare, and about 12.8 billion was out of pocket for these individuals[1]. The latest statistics estimate that the prevalence of obesity in adult men and women is between 31% and 35% [1, 2]. Likewise, more than 25% of U.S. children are considered clinically obese.

The current recommendation for physical activity is 60 minutes of moderate physical activity 5 days out of the 7-day week. An estimated 40% of adolescents spend 3 or more hours watching television, and 33% of adolescents get physical education classes in school [2]. Girls have been found to be less active than boys in their teenage years [3], which potentially puts them more at risk. Previous studies have also found that some factors affecting a child's physical activity include their parents' exercise patterns, their enjoyment of physical activity, friends' support of exercise, and self-efficacy [3].

Many free or low-cost fitness and exercise programs exist, but teens do not take full advantage of them. Major contributors to the lack of consistent participation from teenagers in these programs include transportation obstacles. Teens rely heavily on their parents and their parents' schedules for transportation needs. Our system addresses this issue by running on a mobile device which can then be kept on the person at all times and can be used anywhere.

Although a lack of physical activity is not the only factor affecting obesity prevalence in teenagers, it can help them maintain healthy weights. Our system attempts to make physical activity more enjoyable, allow for friends and family to become involved, and improve their self-efficacy views by providing verbal motivational support and physical activity games running on a mobile device. In the following we begin by going over previous systems that address physical activity in adults or teens, our proposed solution, the status of the research, our contribution to the field, and information about the authors.

## Background

In the literature, there exist studies and applications developed that address increasing or maintaining healthy physical activity levels in individuals by using a game-like environment, friendly competition, or physical activity awareness and monitoring. In the following, we describe a few of these prior systems.

Motivation is an essential factor that can cause a person to start physical activity, do more physical activity, and continue their physical activity routines. A lack of motivation or the wrong kind of motivation can also have negative effects in which the user stops using the system or doing the behavior. One approach to increase motivation includes encouraging friendly competition such as in Chic Clique and Houston [4 - 7]. People who used Houston stated that their physical activity was not accurately measured, which was due in large part to the limitations of pedometers. Users also complained that the pedometer was too bulky and called attention to the users.

Another approach includes physical activity based games such as Neat-o-games, Human Pacman, and Mario Fit [8 - 10]. The games are usually controlled with data from an accelerometer or GPS. However, not everyone enjoys the social interaction required to play these games, and people may not want to purchase additional hardware, as is necessary to play Human Pacman.

There are also systems that aim to assist users with their physical activity routines. An example of such a system is MOPET. MOPET is a system that records heart rate and speed and focuses on providing the user with tools to analyze their fitness progress. MOPET also has a virtual trainer that demonstrates how to do exercises and encourages the user to try them [11, 12]. The application was targeted to physical activity outdoors and jogging. They found that gentler and softened motivation was more effective. This work outlined features of a good visual display for physical activity [13]. Again this application is more suited towards users who want to develop exercise routines.

Finally, there are systems that were created based heavily on theoretical concepts. One such system is UbiFit Gardens. UbiFit Gardens was developed according to several theoretical guidelines including those from cognitive dissonance theory and the transcontinental model. They created non-intrusive physical activity technology that would blend into the user's everyday world. Their user study consisted of adults who wanted to increase their physical activity [14]. The applicability to teens was not explored.

Most of these systems target adult users who have already expressed a desire to be physically active. To our knowledge, little work has been done in addressing and predicting technology designs that would motivate teenagers to become or continue being physically active. By targeting teens we hope to encourage physical activity and healthy lifestyles at an early age to try to combat obesity and overweight trends in later years. The proposed research attempts to further research in this area by approaching the design of such a system from several theoretical models that will shape different aspects of the system design and personality theory that will help to shape the individualized motivational aspects of the system.

## Proposed Solution

Fitness and physical activity teen programs face problems such as a low number of participants and inconsistent attendance by those who do sign up. One of the major obstacles for teenagers is that they must rely on their parents for transportation to the facilities where these programs are held. By developing our application on a mobile device we have eliminated the transportation issue. For our pilot work, we focused on motivation and making exercise fun. We accomplish this by asking teenagers to play games that are location or accelerometer based and that require physical activity. Our system also uses personality information as determined by the Big 5 personality theory to recommend games for the user and motivational phrases to play (see figure 1 and figure 2 for a state diagram of the system).

The main theories used to shape this design were the Technology Acceptance Model (TAM), the Theory of Planned Behavior (TPB), the Theory of Meaning Behavior (TMB), and the Big 5 Personality Theory. The technology acceptance

model tries to predict if a technology will be accepted and adopted by users. This model says that in order for a system or technology to be accepted it must address two key components: perceived usefulness and perceived ease of use [15]. Perceived usefulness is a reference to how much the user thinks this technology will be useful and helpful to get the task done. The user must also believe that it will be easy or straightforward to accomplish the task with this new technology (perceived ease of use). TAM is used to shape the whole system design, i.e. the system is designed to perform and provide useful information for the user and the interface is designed in a way familiar to the user group.

The theory of meaning behavior accounts for how both external and internal incentives promote behavior change [16]. External incentives can be thought of as rewards for behaviors, such as getting a treat if you get good grades or a medal if you participate in sports. Internal incentives are incentives which we have internalized and associated to personal rewards such as 'personal enjoyment'. Our design begins by using external motivators such as the motivational agent and phrases. We hope the internalized motivator will be an association of physical activity to a fun and 'easy' behavior.

The theory of planned behavior says that there are key components that affect behavior. These components are perceived control, subjective norms and attitudes, and behavioral intention. In TPB, perceived control is based on how easy or difficult the individual believes performing the behavior will be [17]. Subjective norms and attitudes refer to the influences that other people whom the individual likes or considers important affects his or her behaviors. Finally, 'behavioral intention' refers to whether or not the person wants and plans to do the behavior. Our system encourages intention and perceived behavioral control through the motivational phrases spoken by the motivational agent. Likewise, we believe using games will increase perceived behavior control and will also adhere to the social norm of playing games for this target group.

The Big 5 personality theory is then used to personalize the system to each user. Personality codes are determined for each user and used to decide which games to suggest to the user and what motivational phrases to play. We believe doing so will enhance the user's experience and it will improve the likelihood that interaction with the system will be found to be more enjoyable and motivating as a result.

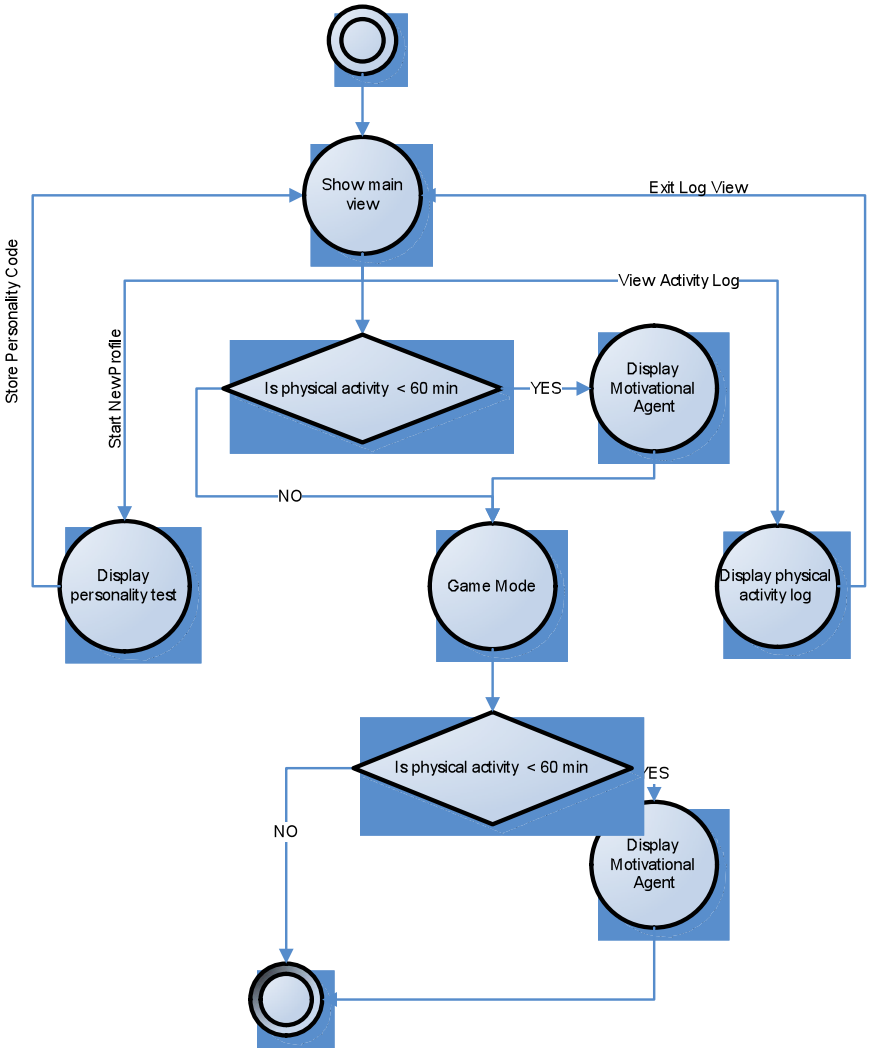


**Figure 1 - State diagram of system**

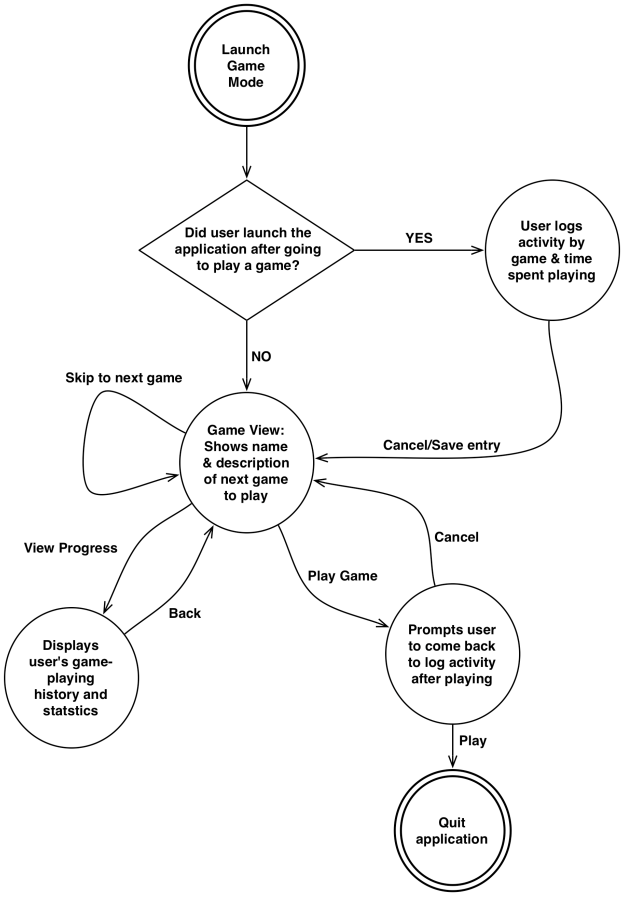


**Figure 2 - State diagram of system's 'Game Mode'**

Once the application is launched, the system presents the player with a list of games tailored to their personality. For example, an extroverted teen would likely enjoy playing games outdoors with a group of friends, whereas an introvert may prefer a game that can be played alone. Each game is better or less well suited to certain personality traits, but all games involve physical activity and interaction with the real world. There is considerable variety in types of games: games that involve physically searching for a virtual treasure the player sees on a map, games that involve using the mobile device as a sword, and group competition based games.

The system recommends an ordered list of games compatible with the user's personality, but the user is free to skip forward or backward between games (see Figure 3), giving the user control over what to play next. Allowing a choice of several games should give the user perceived behavioral control (which is a motivator for behavior change according to the Theory of Planned Behavior), and allows users to avoid games they cannot play at the moment (due to constraints like not enough players, needing to stay indoors, etc.).

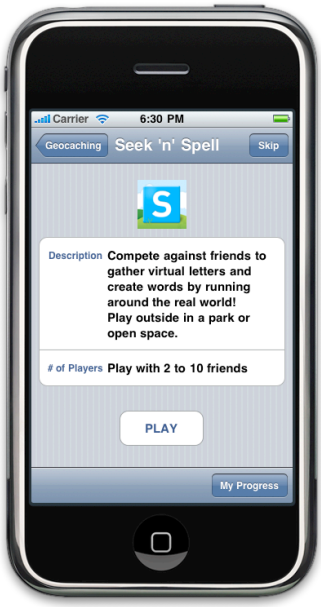


**Figure 3 – Screenshot of the system suggesting a game to play**

When a user decides to play a game, the system remembers what game it was, so that when the user opens our system again, they are prompted to log playing that game. This record goes towards a daily, weekly, and overall physical activity total, which a user can view at any time by tapping the “My Progress” button. Seeing a visual representation of their progress over time is designed to give the user feedback, which is essential in motivating continued use. After logging physical activity game play, the user is again taken to the games list and the next game is suggested. Figure 2 shows the state diagram for the user interaction for the system.

The motivational aspect of our design is accomplished through the incorporation of a motivational agent, whose spoken phrases are chosen based on the user’s personality. To determine the user’s personality, a shortened version of the traditional Big Five Personality test is used. This ten-question test is more suitable for use on our system because the user may not want to spend too long filling out questions prior to game-play. The personality test chosen has been shown to be a good substitute for the full, forty-question test [15].

Two agents have been created for this application to cater to different personality types (Figure 4): a polite and encouraging female agent and a male agent more akin to a drill sergeant. In a focus group, the participants reacted very positively to the female agent, saying, “She seemed really nice” and “I would keep playing if she would tell me nice things”. With the MOPET system, gentler motivation was found to be more effective, so the motivational phrases have been designed to be very positive.

The agent condones physical activity levels when the user has obtained the goal of more than sixty minutes of activity on a given day, by having the agent say a phrase such as, “Great job! You are really on top of things!” If the activity level has not reached sixty minutes, the agent will say a phrase such as, “Why don’t we try playing for another thirty minutes?” or “Let’s try more activities tomorrow!” The phrases have also been tailored to match certain personalities; for users with a high extroversion factor an example phrase would be, “Tomorrow, invite a friend to play!” For users with a high introversion or antagonism factor, an example phrase would be, “Why don’t we try playing a game? It will be fun!”

**Figure 4 – Motivational agents used in the system**

## Pilot Study System Implementation

This summer we developed a prototype application running on an iPod Touch and iPhone. We gathered questionnaire data from over 25 teenagers, and completed a focus group and user testing of our system with 6 teenagers.

In the pilot study, we have chosen to develop our system for the iPhone and use existing iPhone games involving physical activity, rather than creating our own. Using existing games has allowed us to create a quick prototype in which we will be able to get feedback from our focus group about what games the teens did and didn’t like, and which they would be interested in continuing to play. For the long-term study, the goal would be to use this feedback as a basis to actually create our own games that teens would find fun, and integrate them as part of the application.

Although the ability to use existing games is an advantage in our pilot study, the iPhone platform is limiting in that developers cannot run their applications in the background. This means we cannot gather accelerometer data or GPS data while the 3rd party game applications are running, and must rely on the user to log their play the next time they open our application. In an integrated game system all logging would be done automatically, in order to make the interface as unobtrusive as possible.

## Results

Our data is the result of interviews with the user-study participants over the course of four meetings with each participant, and a larger group interview. The interviews focused mainly on the participants' experience using the application, but also general attitudes towards physical activity and technology, in relation to the motivational and psychology theory our design was based on.

The participants felt comfortable overall using the iPhone/iPod Touch and our application. Although none of them had an iPhone themselves, they were able to pick it up immediately and know how to operate the device. They found it easy to take the personality test at the beginning of the application, and to navigate our system to choose games they wanted to play. After playing a game, they were able to log the amount of time they played when they returned to our application, but participants described this action as a little more difficult: that they "had to think about it a little bit" and that it would be easier if they did not have to remember the amount of time they played themselves. None of the participants noticed the progress view (where they could see the amount of time they played over the course of a day and a week). However, even though these two parts of the interface were difficult, the participants still felt at ease using the system and that they had control over the application.

Among the games we tested, the most popular were the ones that were simplest and easiest to understand at a single glance. Fighting style games (like a kung-fu game) were the most popular, and easy to master in a matter of minutes, while the slower paced map-based games were confusing to participants and they complained that they "couldn't figure out how to move the player" or that they didn't know what to do. There were also games that participants enjoyed after the second or third time playing, like a sword-fighting style game where the device would say commands that they player would have to defend against. After using the system for only a short period of time, the participants found the game frustrating, but after playing with it for more than half an hour they understood how to play better and several said this was now their favorite game. In the long-term study when we develop our own games instead of using existing ones, it will be important to make games easy to play quickly without prior experience or reading instructions.

Many participants gave similar feedback about what kinds of games they would like to play on a future system, saying that they would like games that involved music as well as being active. The girls in particular were interested in having more social games, or ones that could involve competition between friends. One participant described his ideal game as a map-based adventure game. Despite having trouble with a similar game in our system, the participant thought playing such a game would be fun if it were easier to use than the current one in the system.

All of the participants had different levels of physical fitness, exercise habits, and attitudes towards physical activity, exercise, and games. The ones who were physically active on a regular basis did some kind of organized team activity (like cheerleading), and all of them had strong familial or social influences toward this behavior. This fits with the importance of subjective norms as part of the Theory of Planned Behavior. Participants referred both directly and indirectly to getting into sports because they wanted to be more like their sister or brother. For those who were physically active, feeling like their activities were varied was key to maintaining interest – they wanted to feel like they were always doing something new. This was one of the reasons we decided to include a variety of games in our application, and participants also said that they liked it because they "got to do different things… like come outside and play," and that they liked some of the fighting-style games because they were "the most active."

Before using our system, most of the participants did not have a positive association with games and could not think that playing games was something that could help someone to be healthy. When asked about standard gaming systems like the PS2, XBOX, or the Wii, most participants said they had one of these in their homes but did not play very often. Most identified a younger sibling as the primary user, and said that they thought their family members and siblings would also enjoy our system and want to play with it together.

During the pilot study, we weren't able to distribute the devices to participants for extended use. Most participants said that while they found the games fun, but some weren't sure how often they would play it on their own. Playing often is key for the system to become an effective motivator for regular physical activity, so this is one of the key questions for the long-term study.

## Research Goals and Contribution to Field

Our goal is that by playing games our users will associate physical activity with positive feelings and memories. These positive associations will become internalized motivators for teens to continue physical activity for many years to come. Once these motivators are internalized it is more likely that long-term behavior change will occur and the users will no longer require our system to motivate them.

We hope this work will contribute to the knowledge of system designs that will encourage long term behavior changes in teenagers. We also hope this work will contribute to a better understanding of the design requirements for this targeted user group, the theoretical foundations that best describe their behavior, their mental models and how these play a role in system design.

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