ABSTRACT
This paper reports the design requirements of personalized mobile persuasive games to motivate teenagers to start and continue being physically active. Being physically active can lead to reduced risks of having weight and cardiovascular problems; however efforts in this direction had variable success. Designing technology that will be engaging and motivating for teenagers requires an understanding of the factors that contribute to behavior adoption in teenagers. To understand these, we approach the design from several theoretical models: Theory of Planned Behavior, Theory of Meaning Behavior, and Personality Theory. Mobile applications can help overcome barriers to exercise, such as transportation and access to facilities. They are also personal and pervasive. Games were chosen because they are perceived to be fun by teenagers. Results from our study are summarized, as well as lessons learned and future directions of this work.

Categories and Subject Descriptors
H.5.2 [Information interfaces and presentation (e.g., HCI)]: User Interfaces – prototyping, theory and methods, and graphical user interfaces.

General Terms
Design, Experimentation, and Theory

Keywords
Teenagers, Persuasive Technology, HCI, and Motivators.

1. INTRODUCTION
In this paper, we discuss the user requirements of a mobile system created to motivate teenagers’ physical activity. We also discuss important lessons learned when working with teenagers, as well as when designing applications to motivate their physical activity. The goal of our work is to better understand this user group to develop applications and design guidelines to encourage healthy physically active lifestyles.

Obesity is a growing health concern amongst youth. An estimated 25% of adolescents are obese in the United States [27]. Obesity prevalence is also increasing among states in Mexico, and are higher in areas bordering the U.S. [15]. Obesity in adolescents and teenagers is attributed to increased sedentary lifestyles and poor eating habits.

Health concerns have increased along with obesity prevalence. These concerns are due in large part because of the health outlook for such individuals. Obesity increases the risks of developing heart diseases, diabetes, and some cancers, which is expected to further burden health institutions [7]. More specifically, recent years have seen an increase in the number of individuals with diabetes which parallels obesity prevalence [34].

For teenagers and adolescents, many obstacles to physical activity and exercise include time, community safety, accessibility to physical activity facilities, and transportation to physical activity services [17]-[46]. Technology can aid in facilitating physical activity by providing immediate assistance to the individual anywhere anytime. The ubiquity of cell phones and mobile devices make them a prime candidate to reach individuals in remote areas, as well as individuals of low economic status and third world countries. For example, in 11 low income individuals in Mexico had a cell phone in 2003 [26].

Studies have also shown that obese adolescents have a probability of 70% of becoming obese as adults, as opposed to 50% for a child whom is obese at the age of six [15]. To reduce risks of adult obesity, we need to target preventive measures during an individual’s adolescence and teenage years. By doing so we hope they will adopt these healthy behaviors and continue to practice them well into adulthood.

To better understand teenagers’ perceptions, we reviewed studies of health-related behavior adoption by teenagers. There was evidence that adolescents adopt certain behaviors for different reasons than adults do. Motivators for their behavior are related to their “emotional worldview” [37]. We need to better understand this emotional worldview, and how to translate such worldview into a set of design requirements to affect long term adoption of any system designed to motivate teenagers’ behavioral change.

Motivation is an essential factor that can cause a person to start, maintain and/or increase physical activity levels. The wrong kind of motivation can also have negative effects in which the user stops using some or all of the system elements [39] or results in decreased motivation levels [4].
Theoretical frameworks from health and psychology fields can lend a hand in understanding motivation, which can then be translated into design elements of persuasive applications for the targeted user group. In the following sections, we discuss previous work, the theories applied in the design of our application, preliminary findings from a pilot study with our prototype application, as well as lessons learned.

2. PREVIOUS WORK
Several applications have been developed that encourage physical activity in individuals by using friendly competition, physical activity awareness and self-monitoring, and game-like approaches. In the following, we describe a couple of these prior studies and a brief description of the systems.

2.1 Competition
Encouraging friendly competition among system users is one approach to increase motivation to do physical activity. Examples of these kinds of applications are Chic Clique [39], [9], Fish N’ Steps [25], and Shakra [2]. Chic Clique and Fish N’ Steps both asked users to use a pedometer to record step count. The step count was then shared with friends or peers, which motivated users to push themselves harder to keep up with or outperform their peers.

In Chic Clique the step count number was automatically transmitted to their friends’ PDAs. From this study they found that some teens expressed concern that the competition aspect might lead to excessive exercise and have negative effects on their friendships. However, some also said that it helped them to become more comfortable about talking about exercise with their friends [39], [40].

In Fish N’ Steps, step count affected the visual appearance and growth of a virtual fish in a communal fish tank. Fish from other participants were also in this virtual tank [25]. They found that participants bonded and became attached to their fish. This bond and sense of responsibility for their fish made them want to do more steps so that their fish would be happy.

Instead of a pedometer, Shakra used cell phone signal strength to determine the location of the user. From location information they were able to compute distance and speed of movement. Based on the speed and distance they would automatically determine what kind of activity the user was participating in, i.e. driving, running, or walking. This system also contained the capacity to share physical activity information. In this study, some participants chose not to participate in the sharing capabilities and used the system primarily to monitor their own progress.

2.2 Self-Monitoring
Self-monitoring entails applications that contain physical activity logging for the user (both manual and automatic), as well as goal setting capabilities. Recent studies have shown that self-awareness of physical activity levels resulting from self-monitoring can be enough for the user to become motivated to set goals for him or herself and to push themselves to have higher levels of physical activity. Previous work that demonstrated increased motivation as result of self-monitoring includes Houston [10], MOPET [4], [5] UbiFit Gardens [12], and Nike+iPod [42]. Houston uses step count from a pedometer to measure levels of physical activity. Step count values are used to show progress towards a goal that is automatically determined by the system [10]. Participants in this study expressed that they plan to set fitness walks with friends instead of sitting and chatting [10]. However, individuals who used Houston also stated that their physical activity was not accurately measured, which was due in large part to the limitations of pedometers. Users also said the pedometer was too bulky and called too much attention to them.

MOPET uses sensors to record heart rate and speed. This information is then presented to 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 [4], [5]. The application itself was targeted to outdoor physical activity and jogging. They found that gentler and softened motivation was the most effective [28].

UbiFit Gardens is an application that was developed according to several theoretical guidelines including those from cognitive dissonance theory and the Transtheoretical Model. Their application was targeted on creating a non-intrusive technology that would blend into the user’s everyday world [12]. Their application was a creative aesthetically pleasing self-monitoring tool that provided functionality for the user to self document their physical activity. It also provided automatic recording of walking, running, cycling, use of elliptical trainer, and use of the stair machine [11].

2.3 Game Environments
Game-like environments and games are also used to encourage physical activity by emphasizing the perception that physical activity can be fun. Applications and systems using this approach include Neat-o-games. Neat-o-games are a collection of games that uses accelerometer information as control input to the game. Winning or losing in the game is directly linked to the amount of physical activity the user is doing and thus encourages physical activity through competition with the computer or a friend [16]. Points are given for games won, and these points can be used to get hints for a Sudoku game. Among the findings in this study were that users’ believed they needed more motivational messages from the game and that playing against the computer was not fun.

Other physical activity game-based applications include Human Pacman and MarioFit. Human Pacman is a social game that uses the physical world as a virtual Pacman playing area [8]. The game requires multiplayer participation and has been found to be a good form of exercise by users. However, the equipment required is bulky, heavy, and quite expensive.

MarioFit is a similar game to Human Pacman that runs on a mobile device. To make the Mario character jump, run, walk or arm throw, the user needs to physically jump, run, walk, and arm throw [23]. The creators of MarioFit were not sure if the game choice was motivating enough and were unsure if the game would have a positive effect in the long run. Other examples of games similar to MarioFit include Feeding Yoshi and Paranoia Syndrome [21], [3].

There are also games that use sensors and physical objects to enable the desired motion. There is a body of literature that refers to these types of games as Exergames. These games include Life
is a Village, FlyGuy, Wii Sports, Dance Dance Revolution, and game-bike[44], [43]. [22], [6].

Life is a Village is a game that requires that the user physically pedals a bike to move a character around the virtual world. The goal is to pick up items to build a village [45]. This game also uses music to try to keep the game atmosphere pleasant and to motivate physical activity. Results from “Life is a Village,” also found that positive feedback was an important motivator.

Most of the literature on physical activity applications targets adult users. Most of these applications aim at assisting users in their exercise routines, physical activities, and goal setting. To our knowledge, little work has been done in addressing persuasive technology designs that would motivate teenagers to increase their levels of physical activity. It is vital that we better understand the motivators for this user group and the translation of these motivators into system design.

3. MOBILE APPLICATION
3.1 Theoretical Approach
As a starting point in understanding teenagers’ emotional worldview, we investigated psychological and health-related theories related to adolescent behavior adoption. Two of the most prominent theories in this regard are Theory of Planned Behavior (TPB) [24] and Theory of Meaning Behavior (TMB) [37].

TPB states that behavior is affected and depends on behavior beliefs, normative beliefs, control beliefs, and intention where each means the following [24], [20]:
- Behavioral Beliefs: refer to the belief that a perceived outcome will occur as a result of doing the behavior and the attitudes towards the behavior
- Normative Beliefs: refer to the individual’s perception of what people he or she cares about will think about the behavior in question
- Control Beliefs: refer to the perceived obstacles or ease of performing the behavior and their perceived capabilities and abilities to perform the behavior
- Behavioral Intention: refers to how much a person plans to do and wants to do the behavior [29]

The second theory we focus on is the Theory of Meaning Behavior (TMB). This theory states that there are two kinds of motivators, extrinsic and intrinsic motivators. Intrinsic motivators are those associated with the individual and appeal to emotional/personal gains, such as ‘happiness,’ ‘fun,’ or ‘it’s entertaining.’ Extrinsic motivators are those that have to do with environmental factors such as a coach telling the student they are doing a good job, or winning an award for perfect attendance [37].

TMB predicts that behavior change in exercise behavior can be accomplished by effecting change in both intrinsic motivation to perform physical activity and the meanings of physical activity. Therefore, based on the TMB, if the designed system can induce health-related behaviors through positive affect, it will increase physical activity and decrease sedentary behavior in our target youth population.

In terms of affective states, psychologists typically distinguish between emotions, moods and personality. Emotional dispositions – being cheerful or aggressive – are usually thought of as personality traits. One theory that explains personality traits is the Big 5 personality theory [33]. This theory states that there are 5 basic traits that can completely describe an individual’s personality and that different interventions and persuasion styles are required for people with different personality traits.

3.2 Application
To further understand the design requirements of this specific user group, we designed an interface that takes advantage of pre-existing iPhone/iPod Touch compatible games. Interaction with the interface begins by first asking the user to complete a short personality questionnaire. The results from this personality instrument are then used to determine a list of games to display to the end user (see Figure 1a and 1b).

Games were classified with the different personality types based on the trait descriptors by three raters. The application then uses a point scheme to pick out which games to choose as the best matches for the user. Five games are selected for each user and each is displayed with a description and number of players needed (Figure 1b).

The user then clicks on the game icon and the application informs the user that the application will exit and they need to click on the game icon on the systems main screen. This pop-up also reminds the user to return to the application and manually log their game playing time (Figure 1c and 1d). The SQLite database implemented into the application stores these values for the user and updates an activity view.

Each time the user opens the application and the total recommended activity level has not been met, a talking head is displayed that says a motivational phrase (Figure 1e). Examples of these phrases are:
- Get in a group together and play
- Today invite your friends to play
- Let’s go outside and do something fun!
- Let’s keep playing you are doing great!

The games available for the participants to use included geocaching games, treasure hunt style games, and accelerometer based games. The geocaching and treasure hunt games require that the user walks around the physical space to interact with the games. For example, in Seek N’Spell, the user has to physically walk to the location of various letter blocks in order to use those letters in a Scrabble-like game.
Accelerometer games were games that involved accelerometer data as input to the device. One example is a jump roping game, where the system is used as the handle bars of a jump rope and the user has to jump. Another game is a samurai game, where the device is used as a sword. The device is swung in various directions to do the different defense and attack actions, which require various arm movements.

4. FOCUS GROUPS AND SURVEYS
Our requirements gathering began with the distribution of surveys to a school in <anonymous> county. We received 28 completed surveys. The survey participants were on average 17 years old, weighed on average 140 pounds, and 25 out of the 28 participants were Hispanics. They were in middle school or high school at the time the surveys were administered and completed.

The survey asked questions about social motivators, self perceptions, physical activity levels, and perceptions on physical activity. Some sample questions from this survey were:

- I feel my knowledge about exercising is above average
- I like to play games with my family
- I am comfortable talking about exercise with my family and friends

As a follow up, we conducted focus group discussions and user testing with our application over the course of four weeks. During the focus group discussions, we discussed the talking head’s appearance and motivational phrases. We also discussed what the teenagers liked to do for fun and their motivations for becoming involved in active sports or sedentary activities.

Five teenagers participated in the focus group discussions (4 girls and 1 boy). The participants represent a wide range of ages: 12 years old (2 participants), 13 (1), 16 (1) and 17 (1).

5. RESULTS SUMMARY
From the survey that we conducted, we learned several things:

1. Individuals with certain personality traits are more likely to be perceptive toward the idea of physical activities and having a mobile device that can assist them to do such activities.
2. Individuals with certain personality traits are more likely to have positive normative, control and behavioral beliefs.
3. Most of our respondents do not show evidence of internal motivators for physical activities.

In general, the results of the survey indicate that there is a need to personalize the application to match the users’ personality traits. From the focus group discussions we also learned several things:

1. Games can be used to promote positive behavioral beliefs. The focus group came up with the characteristics of games that are desired, which are: games that allow for socialization and/or competition, can be played outdoor, simple to learn and with a lot of variations.
2. Regardless of the personality traits, teenagers like to hear positive phrases that imply that they are doing great in their physical activities.
3. The favored games vary by personality traits.
4. The use of a talking head to make the device more anthropomorphic was perceived positively, although there was an expectation to make the agent to look more realistic.
5. There is some evidence that it is possible to induce internal motivators using our system, although not at the level of physical activities that is recommended by the Department of Human of Health and Human Services.

6. DISCUSSION
From our study we learned about teenagers’ emotional worldview and gained insight into designing a mobile persuasive system for them. However, in order to completely test the reliability and validity of our theoretical approach, we need to conduct a longer user study to test for long-term behavior adoption.

We believe that the ubiquity of mobile devices can be used to assist and help teenagers improve their physical activity levels throughout the world. The fact that cell phones are prominent in low income areas is an indicator as to how using mobile systems
can help to reach users of various economic backgrounds. However, there are several issues that we need to consider to design a system that can effectively motivate teenagers and adolescents to change their behavior regarding physical activities and exercise. These issues are presented in Section 7.

Future work will involve a similar user study in Mexico. We also plan to run the longer study with an improved version of our prototype application.

7. PRESENTATION FORMAT
Several themes emerged from our user study, which can be summarized as the following:

1. Our users requested an automatic logging of user activity and a larger variety of games.
2. Our user research, combined with established psychological and health-related theories, had helped us understand how to design an application that matches the emotional worldview of our user group.
3. There is a need to personalize the application to match users’ personalities and preferences.

Consequently, we chose the presentation format of this paper by dividing it into 2 sections. The first contains a summary of the study that we performed and is reported in this paper. The second but the most important section of the presentation will discuss the three aforementioned themes. Author 1 will lead the discussion on mobile games and the use of sensors that are widely available in smart phones for user monitoring. Author 2 will lead the discussion on translating user research to design requirements. Author 3 will lead the discussion on personalizing technology to match user personalities and preferences.

8. ACKNOWLEDGMENTS
We would like to thank <anonymous> county’s Transportation Department for providing the testing facilities in the area. Lastly, we want to thank our participants for their insightful comments and participation.

9. REFERENCES


10. **Appendix**

**Proposed speakers:**

**Marilyn Walker**

Marilyn is a Professor of Computer Science at the University of California, Santa Cruz. Prior to joining UCSC, she was a professor at the University of Sheffield, U.K. She has extensive research experience in dialogue analysis and dialogue systems. She has also worked on several mobile dialogue system applications when she was Principal Member of Technical Staff at AT&T Labs Research from 1996 to 2003. She has experience with building dialogue systems using speech recognition and text to speech modules and is recognized for her empirical approach to research.

**Research Interests**

My primary research interest is in Dialogue processing and Automatic Adaptation and Personalization. Specifically, my research focuses in three main areas:

1. Developing algorithms and methods for understanding and generating individual differences in dialogue behavior both in human human dialogue and in the way a person interacts with a spoken dialogue system.

2. Methods for evaluation of dialogue systems, or dialogue analysis techniques to pay attention to what really matters for functionality and usability.


**Selected Publications**


**Sonia M. Arteaga**

Sonia is a Ph.D. candidate at the University of California, Santa Cruz and has been working on this research for a little over a year. Her educational focus is on HCI and she has been involved in other HCI projects in the past. This body of work is also directly related to her thesis focus.

**Selected Publications:**


Sri Kurniawan

Sri is an Assistant Professor at the University of California, Santa Cruz. Prior to joining UCSC, she was a professor at the University of Manchester. She is Sonia’s advisor and has been working in the area of HCI and Assistive Technologies for many years. She has extensive research experience in assistive technologies and in with working with children. Sri has also worked on other mobile applications in the past.

Selected Funded Projects

- **2008-2009**: Principal Investigator, Virtual Speech Therapist for Stroke Survivors. CITRIS (The Center for Information Technology Research in the Interest of Society)
- **2008-2009**: Principal Investigator, Virtual Speech Therapist for Stroke Survivors with Aphasia in Rural Malaysia. UC MICRO
- **2008-2009**: Principal Investigator, Virtual Speech Therapist for Stroke Survivors with Aphasia in Rural Malaysia. Microsoft Research
- **2007**: Co-Principal Investigator, Mobile Therapy for Stroke Survivors. Government of Malaysia
- **2005**: Principal Investigator, Making Mobile Phones More Useful for Older People. The British Society of Gerontology's Averil Osborne Award

Research Interests

My primary research interest can be described as HCI for people with special needs. Specifically, my research focuses in three main areas:

4. Developing a series of theories to predict how older persons and people with disabilities interact with computers and their applications (including the Internet) and developing artifacts to validate those theories/models.

5. Developing theory-driven systems that alleviate functional limitations experienced by young children, older persons, people with disabilities, and people in extraordinary circumstance (e.g., people whose first language is not English needing to access English websites).

6. Evaluating existing or designed artefacts with people with special needs (in a controlled experiment or in context) to observe usability problems, and user behaviour and attitude, for the purpose of gaining a truer and deeper understanding of the problems experienced by these people.

Selected Publications


**Proposed Time:** We expect this presentation to be about 30 minutes long.

**Proposed Format:** PowerPoint presentation of research with three speakers, followed by a discussion.