

# Personality & Persuasive Technology: An Exploratory Study on Health-Promoting Mobile Applications

## ABSTRACT

Though a variety of persuasive health applications have been designed with a preventive standpoint towards diseases in mind, many have been designed largely for a general audience. Designers of these technologies may achieve more success if applications consider an individual's personality type. Our goals for this research were to explore the relationship between personality and persuasive technologies in the context of health-promoting mobile applications and investigate perceptions toward different persuasive technologies. We conducted an online survey with 360 participants using storyboards depicting twelve different persuasive strategies, the Big Five Inventory for personality domains, and questions on perceptions the persuasive technologies. Our results and analysis revealed several significant relationships between personality and the persuasive technologies we evaluated. We also present interesting findings on perceptions toward different health-promoting mobile persuasive technologies. The long term goal of this work is to use the findings to develop persuasive technologies catering to individual personalities for maximum success.

## AUTHOR KEYWORDS

Preventive Medicine, Healthy Living, Persuasive Technologies, M-Health, Personality, User-Centered Design, Amazon Mechanical Turk, Quantitative Methods

## ACM Classification Keywords

H.5. Information interfaces and presentation (*e.g.*, HCI)

## INTRODUCTION

Over the last several decades, we have seen an ideological shift of attitudes toward healthcare in the United States and other nations. As life expectancies and standards of living increase, so has the demand and potential for better healthcare. More of an emphasis should be placed on

preventive measures toward diseases in addition to disease management. This area of medicine, known widely as preventive medicine, is an essential area of health that should ideally be re-emphasized when improving healthcare.

The concept of preventive medicine has been around for some time. In the U.S., preventive medicine is one of the 24 recognized medical specialties recognized by the American Board of Medical Specialties [1]. The scope of preventive medicine is wide, and the consequences are far-reaching [8,14]. A study on leading causes of preventable deaths in 2000 revealed that poor diet and physical inactivity accounted for 16.6% of the total deaths in the United States while smoking accounted for 18.1% [23]. Currently, the intersection between the two influential fields of medicine and computing is growing steadily. The past few years have seen a rise in technologies targeting the promotion of a healthy lifestyle [6,20,22,25,26]. It is not uncommon for individuals to use their mobile phones to track the number of steps taken per day or moderate eating behavior [6,26]. Given the popularity of such technological devices, applications designed to promote healthy living should be encouraged. Preventable deaths may be reduced in the future by doing so.

Persuasive technologies created with the goal of behavior modification in mind can be especially useful in promoting healthy behavior [2,9]. A variety of persuasive technologies have been designed to help people try to quit smoking, eat healthier, or exercise more frequently [6,9,26]. However, many of these applications have been designed mainly for a general audience using a single persuasive technique. Applications customized for an individual's personality type may achieve higher success rates [2].

Two resulting challenges for persuasive technologies designed to promote healthy lifestyles is their ability to sustain user interest over time and their appeal to a broad range of people. Many products that start out fairly general specialize over time to better cater to the needs of its users. The one-size-fits-all era has long been over, and consumers are expecting more from providers across a wide range of fields. Persuasive technologies are no exception. These technologies can better accommodate the needs of diverse

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users and sustain user interest by considering the different personality types of their users.

We had two research questions in mind with this work. First, we were interested in investigating whether significant relationships existed between personality and perceptions of persuasive technologies targeting health promotion. Second, we wanted to investigate overall perceptions toward (a) select persuasive strategies and (b) the general concept of health-promoting mobile persuasive technologies. In our study, we chose to focus on persuasive mobile technologies that promote more physical activity, since that is one of the common applications of health and most individuals currently own a mobile device. To achieve these goals, we conducted an online survey with 360 participants using storyboards, the Big Five Inventory (BFI) for assessing personality, and questions on perceptions of technologies depicted in the storyboards. Our results revealed significant relationships that existed between personality and the persuasive technologies we studied. We also discovered interesting findings on perceptions toward the specific technologies we studied, as well as general, health-promoting mobile persuasive technologies. This work represents the first exploratory study that investigates the correlational relationship between the Big Five personality domains and perceptions on different forms of persuasive technology. The long term goal of this work is to use the findings to encourage the development of health promoting persuasive technologies which can be tailored to individual personalities for maximum success across a diverse population.

The remainder of this paper is organized as follows. We first present related work pertaining to persuasive technologies, personality research, and customizable technology. We then describe the study design, followed by a comprehensive presentation of results obtained from this study. Next, we discuss results and the resulting design implications. We conclude by stating current study limitations and future directions for research.

## **RELATED WORK**

In this section, we present work that is related to persuasive technologies, personality research, and customizing user interfaces based on the particular user.

### **Persuasive Technologies**

The idea of using technology to motivate desirable behaviors has recently become a popular topic within the Human-Computer Interaction community. Originating with the definition of captology by B.J. Fogg [9], the movement has grown to have its own research conference and publishing venues. Researchers have previously worked on developing guidelines and models for persuasive technologies [7], and the application space for persuasive technologies has been well explored. Motivating physical fitness has been one of the most common applications [5,6,20]. Other applications include motivating healthy eating habits [15,21], healthy water intake [4], sustainable transportation [10], and reduced television watching [24].

The work we present here differs from these applications in that although we use the application of motivating physical fitness as the sample in our storyboards, we are not proposing a specific application. Instead, we are outlining the ways that these applications can be customized to be more successful for users based on their personalities.

### **Personality Research**

To understand users' personality comprehensively, we chose to utilize the Big Five factors of personality traits. The Big Five factors are widely known as one of the major means of organizing human personality. Historically, the Big Five Model has been used extensively as a descriptive model of personality [13]. The term Big Five does not imply that personality differences can be narrowed down to a mere five traits. To be more accurate, these factors represent personality at a very broad level [17]. The Big Five factors are Neuroticism, Conscientiousness, Agreeableness, Extraversion, and Openness [13]. According to psychological research, Neuroticism distinguishes the stability of emotions and even-temperedness from negative emotionality, which can be described as feeling nervous, sad and tense. Conscientiousness suggests self-use of socially prescribed restraints that facilitate goal completion, following norms and rules, and prioritizing tasks. Agreeableness distinguishes pro-social and communal orientation toward others from antagonism and includes traits such as altruism, trust, and modesty. Extraversion suggests a lively approach toward the social and material world and includes traits such as sociability, activity and assertiveness. Openness describes the wholeness and complexity of an individual's psychological and experiential life [17]. In this study, we determined how these personality domains relate to perceptions of health-promoting persuasive technologies.

### **Customizing Technology Design based on Users' Needs**

One of the ultimate goals of this work is to motivate health-promoting persuasive technology designers to customize based on the users' personalities. A number of other researchers have recognized the different needs of individuals and realize that the one-size-fits all approach may not necessarily be the best design. Indeed, customizability is one of the key components of a usable user interface. Mobile technology designers have long known that traditional WIMP user interface designs do not translate well to mobile devices. Thus, toolkits like SUPPLE [11] were designed to allow designers to make custom web interfaces based on the device with which the user was browsing. This idea was extended to automatically customize interfaces for individuals with different physical disabilities [12]. Most closely related to our work is Artega *et al.*'s study on combating obesity trends in teenagers through persuasive mobile technologies, which uses the Big Five Personality Theory to guide their design [2]. In their study, they used the Big Five factors to personalize the system to each user. Personality codes were determined for users and used for suggestions on game choice and motivational phrases to encourage users to play. Our study

utilizes the Big Five factors to understand the relationship between persuasive technologies and personality at a broader level, rather than the design of a specific application.

## STUDY DESIGN

In this section, we describe the design of the study and our approach to investigating the study's variables and goals. For this study, we chose to focus on one particular application of persuasive technology on a single form factor: encouraging physical activity through the use of mobile devices.

### Selecting and Conveying Persuasive Technologies

We established a list of different persuasive technology strategies for this study by brainstorming for ideas regarding the design of future related applications, and through a search of the literature on popular health promoting mobile persuasive technologies and common psychological approaches to health related behavior modification. From this list, we selected 12 types of persuasive technologies that could be grouped at a higher level as six general approaches of persuasive technologies. Thus, each approach consisted of two specific persuasive technology strategies representing opposite ends of a continuum. We selected these based on interest and our likelihood to design future apps using these strategies. The six selected pairs were:

- (1) **Instruction Style:** Authoritative and Non-Authoritative
- (2) **Recording Input:** Automated and Manual
- (3) **Social Feedback:** Cooperative and Competitive
- (4) **Motivation Type:** Extrinsic and Intrinsic
- (5) **Reinforcement Type:** Negative Reinforcement and Positive Reinforcement
- (6) **Reward Type:** Real Rewards and Virtual Rewards

We represented these strategies of persuasive technologies through the use of storyboards drawn by an artist. We chose to use storyboards because they provided a common visual language that individuals from diverse backgrounds could read and understand [19]. All of the storyboards used in our study contained illustrations of a character and his/her interactions with a mobile based persuasive technology which promoted exercising. Figures 1-12 on the following page represent the 12 storyboards used in the study.

### Assessing Personality

To assess the Big five factors of personality (Extraversion, Agreeableness, Conscientiousness, Neuroticism and Openness), we used the 44 item version of the Big Five Inventory (BFI), a self-report inventory designed to measure the mentioned factors of personality [3,16,17]. We selected this version of the BFI for its efficiency (five minutes of administration time, compared to fifteen minutes for other comparable measures) [17]. In addition, the items on the BFI are shorter and more understandable.

## Survey Design

We designed six surveys to achieve the study's goals. At the start of the survey, we presented participants with instructions describing the survey and informing them of the study's goals and requirements. Each survey consisted of three sections. Section 1 of the survey was designed to elicit information regarding perceptions on one of the six grand themes of persuasive strategies. Thus, we presented two storyboards, each depicting opposing ends of a general strategy for each participant. Each storyboard was followed by seven questions designed to draw information regarding participant's perceptions of the depicted technology. Section 2 of the survey consisted of the 44 items from the Big Five Inventory. Section 3 of the survey consisted of five questions on the overall perception towards persuasive technologies encouraging healthy behaviors and six demographic questions.

At the end of the survey, the survey presented both storyboards from Section 1 and a multiple choice question that asked the participant to describe the persuasive style used in the in the storyboards. We included these questions to determine whether the content of the storyboards was understood by participants. Finally, all participants were presented with two multiple choice questions asking for obvious information on details of the storyboards. We included these comprehension questions to filter responses from automated scripts or bots. The survey took approximately 7 minutes to complete. Participants were randomly assigned to one of the six surveys.

### Dependent Measures

The dependent measures of interest to this study could be grouped into four main categories:

- (1) The **Relationship** between personality and depicted persuasive strategies
- (2) **Perceptions and comments** to the persuasive technologies depicted in the storyboards
- (3) **Overall perception** towards persuasive technologies for health
- (4) **Demographics** of the participant sample

To investigate (1), participants rated enjoyment of use, likelihood of use, helpfulness to their own health goals, improvement to quality of life, ease of use, and time saving capacity on a 5 point Likert scale measure and answered the 44 items derived from the Big Five Inventory. We used the same Likert style ratings and responses from open-ended questions to investigate (2). To investigate (3), we used multiple choice questions with and without open-ended options to ask participants for content delivery preference, past use and response to technology to modify aspects of general behavior, future likelihood of using technology to promote healthy lifestyles, and aspects of health that they would like to change. We obtained demographic information (4) through multiple choice and open-ended questions on gender, age, educational background, size of city, county, and fluency of the English language.



Figure 1: Storyboard illustrating Instruction Style- Authoritative Persuasive Technology

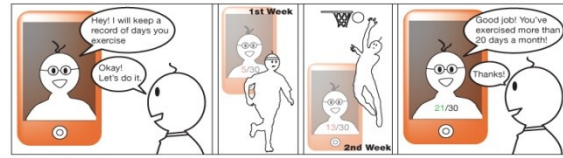


Figure 2: Storyboard illustrating Instruction Style- Non-Authoritative Persuasive Technology

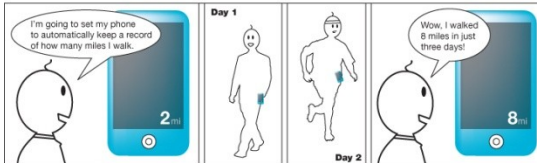


Figure 3: Storyboard illustrating Recording Input- Automated Persuasive Technology

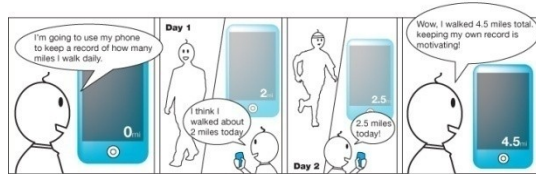


Figure 4: Storyboard illustrating Recording Input- Manual Persuasive Technology

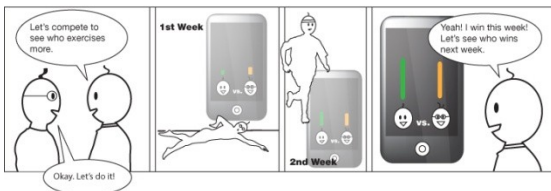


Figure 5: Storyboard illustrating Social Feedback- Competitive Persuasive Technology

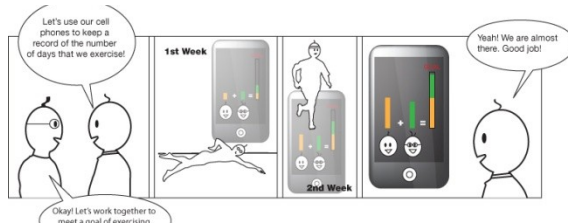


Figure 6: Storyboard illustrating Social Feedback- Cooperative Persuasive Technology

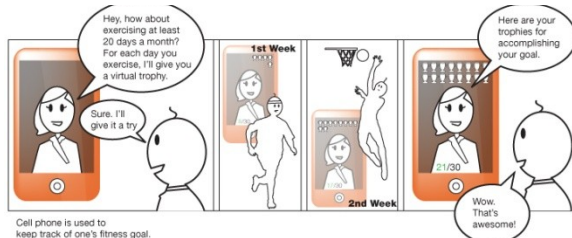


Figure 7: Storyboard illustrating Motivation Type- Extrinsic Persuasive Technology

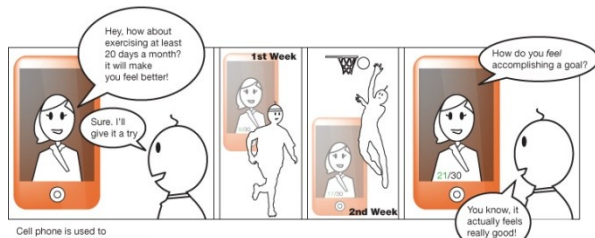


Figure 8: Storyboard illustrating Motivation Type- Intrinsic Persuasive Technology

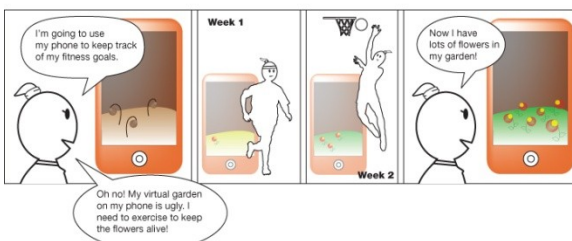


Figure 9: Storyboard illustrating Reinforcement Type- Negative Reinforcement Persuasive Technology

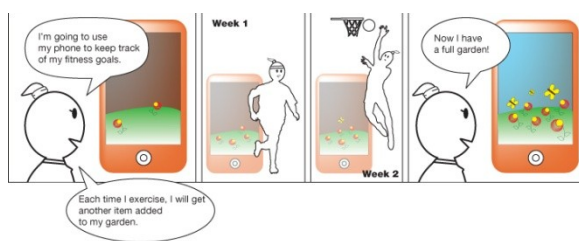


Figure 10: Storyboard illustrating Reinforcement Type- Positive Reinforcement Persuasive Technology

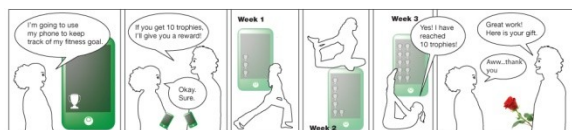


Figure 11: Storyboard illustrating Reward Type- Real Persuasive Technology

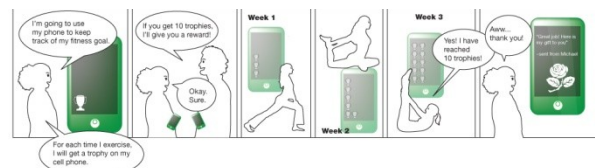


Figure 12: Storyboard illustrating Reward Type- Virtual Persuasive Technology

## Recruitment Strategy

After extensive research, we decided to recruit for participants using Amazon's Mechanical Turk (AMT). Initially created to enable humans to perform tasks which computers were unable to do, AMT utilizes the concept of crowdsourcing to recruit humans to perform these tasks. Although this form of recruitment has its constraints, such as issues with automated bots completing surveys and the possibility for low participant motivation, we decided to use AMT to recruit due to our need for a large participant sample and AMT's global audience, relatively low cost and efficiency of survey distribution. To ensure that the results of the survey were valid, we included comprehension questions to filter out undesired responses, as recommended by Kittur, *et al.* [18] when using AMT for user studies.

After executing two phases of pilot tests of the survey on AMT, a Human Intelligence Task (HIT) was created to recruit participants. By clicking on the link in the HIT, participants were redirected to the university website hosting the online survey. We used a simple PHP script to ensure that participants clicking on the survey link through AMT were randomly assigned to one of the six surveys corresponding to the six study conditions. The 360 participants who volunteered to take part in this study were aged over 18 and from a diverse set of backgrounds. Participants were paid a small token sum, USD \$0.20, which corresponded to standard rates for other tasks recruiting through AMT.

## RESULTS

In this section, we present the results of our survey. This includes the success of the storyboards at depicting the different techniques, the steps we took to filter data, participant demographics, the relationship between personality and the acceptances of persuasive technologies, and the overall comments from the participants.

### Storyboard Success

To determine whether the content of the storyboards was understood by participants, we ran chi-squares on the participant responses to the multiple choice questions which asked participants to identify the persuasive style presented in the storyboards. All results were significant ( $p < .05$ ), except for the storyboard from Survey 6 (Real, Virtual), which was marginally significant ( $p = .051$ ). Overall, these results indicate that our storyboards successfully depicted the selected persuasive technologies strategies.

### Data Filtering

Because we chose to recruit through Amazon's Mechanical Turk, we ran the risk of automated scripts or bots completing the survey, which would consequently result in an inaccurate dataset. To counter this problem, we recruited more than the ideal minimum for each survey and filtered responses by participants who had incorrect responses to the two multiple choice comprehension questions on obvious details of the storyboards. This resulted in a total of 67 out of the 360 responses being discarded (7 from Survey

1, 10 from Survey 2, 22 from Survey 3, 8 from Survey 4, 13 from Survey 5, and 7 from Survey 6).

## Participant Demographics

To summarize demographic information of the participants, we calculated percentages to responses regarding participants' gender, age, education level, fluency of the English language, residency type and country they lived in. Figure 13 represents a summary of participant demographics. In general, we had a relatively diverse population that is representative of the types of users who might use mobile persuasive technologies for health.

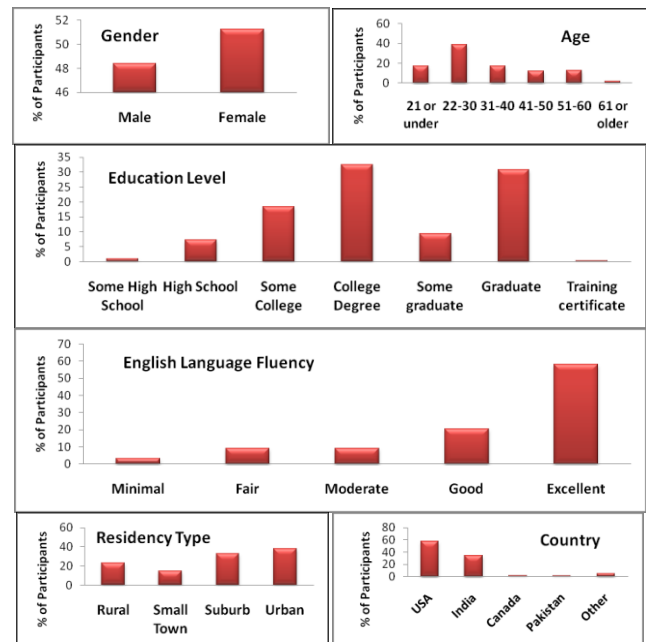


Figure 13: Demographics of participants in the study

### Goal 1: Personality & Persuasive Tech. Relationship

To investigate the relationship between personality and persuasive strategies, we first scored the BFI by reverse scoring all negatively keyed items. We then created the scaled scores for the personality factors by averaging the items for each personality domain. Following this, we ran Pearson's Correlational tests to determine the correlation between the scaled personality scores and the Likert Scale responses to the perceptions regarding the persuasive technologies in Section 1 of the survey. We found significant correlations for all five of the personality traits we tested. Table 1 displays significant correlations ( $p < .05$ ) grouped by personality factor. In addition, Table 1 sorts the significant correlations by persuasive technologies within each personality factor to give an overall sense of which technologies were appropriate for which personality types.

### Goal 2: Perceptions the Mobile Persuasive Tech

The second goal of our study was to understand the perceptions of the users on general aspects of the mobile persuasive technologies depicted by the storyboards in our studies as well as factors relating to health technologies. Table 2 shows perceptions of the study participants on

factors relating to the acceptability of the different persuasive technologies depicted in the storyboards of our survey.

We received a large number of comments for open-ended questions asking participants to react to the persuasive technologies depicted in the storyboards. To best present this qualitative set of responses in a concise manner, we filtered irrelevant responses and designated all meaningful qualitative responses as positive, neutral, or negative. We

then chose one positive and one negative representative comment from each storyboard, which is shown in Table 3.

To investigate the overall perception toward persuasive technologies to promote healthy behaviors, we tabulated frequencies to participant responses to the multiple choice questions in Section 3 of the survey. Figures 14-18 depict participant responses to these questions. All participant data was analyzed using SPSS version 17.

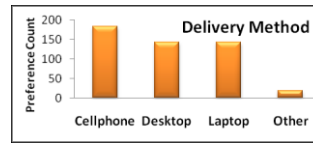
**Table 1: Significant correlations ( $p < .05$ ) grouped by personality factor as calculated by Pearsons Correlational Test. Significant correlations are sorted by persuasive technologies within each personality factor. Negative correlations are indicated in red text, and Positive correlations are indicated in both green and bold text.**

Neuroticism		
Persuasive Tech.	Perception Measures	Pearsons R Value
Cooperative	Improvement to the quality of life	$r(47) = -.387$
Manual	Improvement to the quality of life	$r(56) = +.295$
Negative Reinforcement	Enjoyment of Use	$r(51) = +.299$
Virtual	Enjoyment of Use	$r(60) = +.261$
Virtual	Helpfulness to own health goals	$r(60) = +.318$
Virtual	Improvement to the quality of life	$r(60) = +.289$
Conscientiousness		
Persuasive Tech.	Perception Measures	Pearsons R Value
Competitive	Helpfulness to own health goals	$r(47) = +.293$
Competitive	General Likelihood	$r(47) = +.400$
Cooperative	Helpfulness to own health goals	$r(47) = +.288$
Cooperative	Time saving	$r(47) = +.339$
Cooperative	Improvement to quality of life	$r(47) = +.314$
Real	Ease of use	$r(60) = -.321$
Virtual	Ease of use	$r(60) = -.257$
Agreeableness		
Persuasive Tech.	Perception Measures	Pearsons R Value
Automated	Improvement to quality of life	$r(56) = -.346$
Competitive	Ease of use	$r(47) = +.298$
Negative Reinforcement	Enjoyment of use	$r(51) = -.448$
Negative Reinforcement	Likelihood of use	$r(51) = -.378$
Negative Reinforcement	Helpfulness to own health goals	$r(51) = -.377$
Negative Reinforcement	Improvement to quality of life	$r(51) = -.325$
Positive Reinforcement	Enjoyment of use	$r(51) = -.343$
Positive Reinforcement	Likelihood of use	$r(51) = -.318$
Positive Reinforcement	Improvement to quality of life	$r(51) = -.280$
Positive Reinforcement	Time saving	$r(51) = -.276$
Real	Enjoyment of use	$r(60) = -.329$
Real	Improvement to quality of life	$r(60) = -.320$
Real	Ease of use	$r(60) = -.357$
Virtual	Improvement to quality of life	$r(60) = -.256$
Virtual	Ease of use	$r(60) = -.322$

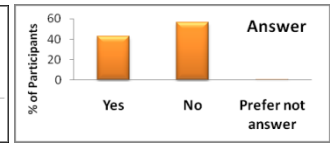
Extraversion		
Persuasive Tech.	Perception Measures	Pearsons R Value
Automated	Time Saving	$r(56) = -.376$
Extrinsic	Improvement to quality of life	$r(58) = -.316$
Extrinsic	Likelihood of use	$r(58) = -.276$
Extrinsic	Time Saving	$r(58) = -.296$
Intrinsic	Enjoyment of use	$r(58) = -.313$
Intrinsic	Helpfulness to own health goals	$r(58) = -.268$
Intrinsic	Likelihood of use	$r(58) = -.309$
Manual	Ease of use	$r(56) = -.266$
Manual	Enjoyment of use	$r(56) = -.362$
Manual	Helpfulness to own health goals	$r(56) = -.354$
Manual	Improvement to quality of life	$r(56) = -.402$
Manual	Likelihood of use	$r(56) = -.444$
Manual	Time saving	$r(56) = -.398$
Negative Reinforcement	Enjoyment of use	$r(51) = -.402$
Negative Reinforcement	Helpfulness to own health goals	$r(51) = -.329$
Positive Reinforcement	Ease of use	$r(51) = -.417$
Positive Reinforcement	Enjoyment of use	$r(51) = -.366$
Positive Reinforcement	Helpfulness to own health goals	$r(51) = -.344$
Positive Reinforcement	Likelihood of use	$r(51) = -.332$
Real	Ease of use	$r(60) = -.284$
Real	Enjoyment of use	$r(60) = -.265$
Real	Likelihood of use	$r(60) = -.338$
Real	Time Saving	$r(60) = -.299$
Virtual	Ease of use	$r(60) = -.283$
Virtual	Enjoyment of use	$r(60) = -.264$
Virtual	Helpfulness to own health goals	$r(60) = -.275$
Virtual	Likelihood of use	$r(60) = -.301$
Virtual	Time Saving	$r(60) = -.370$
Openness		
Persuasive Tech.	Perception Measures	Pearsons R Value
Authoritative	Likelihood of use	$r(49) = +.356$
Competitive	Ease of use	$r(56) = +.404$
Extrinsic	Time saving	$r(58) = -.286$
Intrinsic	Time saving	$r(58) = -.292$
Negative Reinforcement	Ease of use	$r(51) = -.349$

**Table 2: Perceptions on persuasive tech, 1= most positive 5= most negative, (E=Enjoyment of use, L=Likelihood of use, H=Helpfulness to own health goals, I=Improvement to quality of life, U=Ease of use, T=Time saving capacity)**

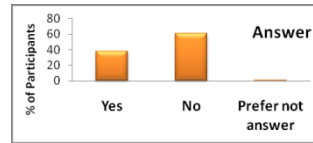
	E	L	H	I	U	T	Avg.
<b>1: Instruction Style</b>	2.2	2.2	2.1	2.3	1.7	2.4	<b>2.1</b>
<i>Authoritative</i>	2.2	2.2	2.1	2.3	1.7	2.5	<b>2.2</b>
<i>Non-Authoritative</i>	2.1	2.2	2.0	2.2	1.7	2.3	<b>2.1</b>
<b>2: Recording Input</b>	2.1	2.3	2.1	2.2	1.6	2.5	<b>2.1</b>
<i>Automated</i>	1.8	1.9	1.7	2.0	1.5	2.3	<b>1.9</b>
<i>Manual</i>	2.5	2.7	2.4	2.4	1.8	2.7	<b>2.4</b>
<b>3: Social Feedback</b>	2.1	2.3	2.0	2.1	1.7	2.3	<b>2.1</b>
<i>Cooperative</i>	2.0	2.1	1.9	2.1	1.7	2.2	<b>2.0</b>
<i>Competitive</i>	2.2	2.5	2.1	2.1	1.8	2.3	<b>2.2</b>
<b>4: Motivation Type</b>	2.4	2.5	2.2	2.3	1.6	2.5	<b>2.3</b>
<i>Extrinsic</i>	2.2	2.4	2.1	2.2	1.6	2.5	<b>2.2</b>
<i>Intrinsic</i>	2.5	2.7	2.4	2.3	1.7	2.6	<b>2.3</b>
<b>5: Reinforce Type</b>	2.2	2.4	2.1	2.2	1.7	2.5	<b>2.2</b>
<i>Negative Rein.</i>	2.3	2.4	2.1	2.2	1.8	2.6	<b>2.2</b>
<i>Positive Rein.</i>	2.2	2.4	2.2	2.2	1.7	2.5	<b>2.2</b>
<b>6: Reward Type</b>	2.2	2.4	2.2	2.3	1.7	2.5	<b>2.2</b>
<i>Real</i>	2.1	2.3	2.0	2.3	1.6	2.5	<b>2.1</b>
<i>Virtual</i>	2.3	2.5	2.4	2.3	1.7	2.6	<b>2.3</b>



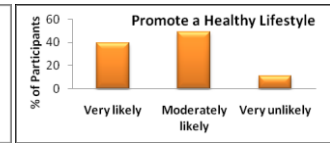
**Figure 14: If you were to use a technology to promote healthy behavior, which would you prefer the content delivered through?**



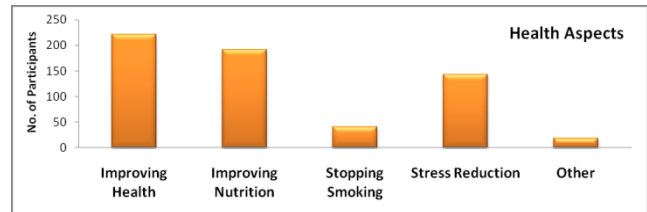
**Figure 15: Have you ever used a technology to modify an aspect of your behavior?**



**Figure 16: Have you ever used a technology to modify an aspect of health related behavior?**



**Figure 17: How likely are you to use a technology to promote a healthy lifestyle?**



**Figure 18: Are there aspects of your health that you would like to change?**

**Table 3: One positive and one negative comment/reaction regarding the persuasive technologies depicted in the storyboards. Numbers to the right of the quote indicates the number of positive or negative quotes about that technology.**

	N	Positive	#	Negative	#	
Survey 1	Auth.	32	Cell phones are used everywhere and all the time in these days. I think this technology would help many people with their health	12	Keeping track of my exercise regime using a cell phone seems tedious	11
	Non-Auth.	34	This technology sounds interesting and will be very helpful if implemented to me (Total Positive: 18)	18	It looks simple, but I don't see why I could not just keep track of my training hours on my own without the techno help	6
Survey 2	Auto	48	I love this idea, as it combines something I would love to have with something I always have, a cell phone	30	Might not be convenient to carry cell phone everywhere.	6
	Manual	40	I love how convenient this is. It is an absolutely wonderful idea!	17	I would not like to enter this info manually as it may not be accurate	17
Survey 3	Coop.	51	Looks fun and simple to work with a friend	23	The synchronization of data between the 2 cell phones would need to be smooth. I have had trouble before getting data to synch together accurately	14
	Comp.	48	I am competitive, so it would encourage me to push myself if I could see my efforts in competition with someone else	24	I don't prefer the competition aspect of the technology	13
Survey 4	Extrinsic	43	I like the way this program works and feel like virtual rewards, so easy to give, are great to encourage people to exercise and stay healthy!	17	Virtual rewards don't have much impact unless there's a social aspect (like other people on a web site can see my virtual rewards). If it's just something I alone see on my phone, I don't have much motivation to collect.	13
	Intrinsic	42	For me, it would be more effective if it reminded me how I felt about my exercise more often & kept a record of responses so I could see the patterns, if any, over the course of a month	10	What happens if you don't meet your goal then you feel terrible...	15
Survey 5	Negative Reinfor.	44	This technology will be really fun to use. A virtual talking person monitoring health and recommending diet will be super	26	Cute idea but how does the phone know you're exercising? If you have to manually input all data relating to your activities then I don't think many people would keep up with it	8
	Positive Reinfor.	29	This would motivate me to use my "down" time - waiting in carpool, getting off the couch between tv shows, etc., to do some form of exercise. The more I do, the more my cell phone garden grows.	15	I feel that I wouldn't ever do anything after I had a full garden. There would be no more motivation to work out	5
Survey 6	Real	38	I think that we all need some motivation in order to achieve our personal goals. If motivation is as close as technology, I'm going for it!	20	I use a pedometer that's easy enough	10
	Virtual	28	Getting a rose from a named person is nice	12	The "gift" at the end seems irrelevant. People won't be motivated into exercising by pictures	13

## DISCUSSION

In this section, we review the results our study uncovered and provide possible explanations for some of the correlations found and how they lead to design implications. We also discuss the limitations of this study.

### Goal 1: Personality & Persuasive Tech. Relationship

As shown in Table 1, there were a number of significant correlations, which we grouped by personality factor. Negative correlations illustrate inversely proportional relationships while positive correlations illustrate directly proportional relationships. With regards to all correlations presented, the larger the number of the correlation, negative or positive, the greater the strength of the relationship. Here we describe the correlations specific to each personality trait and how it might affect technology acceptance.

#### Neuroticism

Neuroticism distinguishes the stability of emotions and even-temperedness from negative emotionality, which can be described as feeling nervous, sad and tense [17]. According to our study, as neuroticism scores increase, so do perception scores for *Virtual* technologies with respect to enjoyment, helpfulness, and improvement to the quality of life. Perception of *Manual* technologies for improvement to the quality of life and *Negative Reinforcement* technologies for enjoyment of use also increase. However, as neuroticism scores increase, perception scores for *Cooperative* technologies for improvement to the quality of life decrease. This implies that individuals who display more neuroticism will be more likely to think that using *Virtual* persuasive technologies is enjoyable, is helpful to their own health goals and can improve life quality. Additionally, these individuals are more likely to think that *Manual* technologies will improve their life quality and that *Negative Reinforcement* is enjoyable to use. Conversely, such individuals are less likely to think that *Cooperative* persuasive technologies will improve their life quality.

#### Conscientiousness

Conscientiousness suggests self-use of socially prescribed restraints that facilitate goal completion, following norms and rules, and prioritizing tasks [17]. In our study results, as conscientiousness scores increase, so do perception scores for *Competitive* technologies for helpfulness to own health goals, general likelihood of use, time saving, and improvement to the quality of life. On the contrary, as conscientiousness scores increase, perception scores for both *Real* and *Virtual* technologies for ease of use decrease. This implies that individuals who display more conscientiousness may be more likely to use *Competitive* technologies overall. Conversely, such individuals are less likely to think that Reward type technologies (both *Real* and *Virtual*) and *Cooperative* technologies will improve their life quality.

#### Agreeableness

Agreeableness distinguishes pro-social and communal orientation toward others from antagonism and includes

traits such as altruism, trust, and modesty [17]. In this study, we found that as agreeableness scores increase, so do perception scores for *Competitive* technologies in terms of ease of use. In an opposing trend, as agreeableness scores increase, perception scores decrease for the improvement to quality of life for *Automated* technologies. For *Negative Reinforcement* technologies, perceptions toward the enjoyment, likelihood of use, helpfulness of their own goals, and improvement to quality of life also decrease. For *Positive Reinforcement* technologies, perceptions decrease for the enjoyment of use, likelihood of use, improvement to the quality of life, and time savings. There was also a decrease in perception of enjoyment, improvement to quality of life, and ease of use of *Real* technologies and the improvement to quality of life and ease of use for *Virtual* technologies. This may indicate that rewards of most types in persuasive technologies are not as effective for people who are agreeable.

#### Extraversion

Extraversion suggests a lively approach toward the social and material world and includes traits such as sociability, activity, and assertiveness [17]. As shown in Table 1, as extraversion scores increase, perception scores for a number of the persuasive technologies we studied decreased. This includes *Automated* technologies for time saving and *Manual* technologies for ease of use, enjoyment of use, helpfulness to own health goals, improvement to quality of life, likelihood of use, and time saving. Perceptions of *Extrinsic* technologies for improving quality of life, likelihood of use and time saving and *Intrinsic* technologies for enjoyment of use, helpfulness to own health goals, likelihood of use also decrease. In a similar vein, as extraversion scores increase, perception scores for *Negative Reinforcement* technologies for ease of use, enjoyment of use, helpfulness to own health goals, *Positive Reinforcement* technologies for ease of use, enjoyment of use, helpfulness to own health goals, and likelihood of use decrease. Finally, perceptions of *Real* technologies along the dimensions of ease of use, enjoyment of use, likelihood of use, and time saving and *Virtual* technologies for ease of use, enjoyment of use, helpfulness to own health goals, likelihood of use, and time savings decrease. There were no positive correlations for any of the technologies with regard to extraversion scores. This may indicate that persuasive technologies in general are not perceived as useful by people with high extraversion scores.

#### Openness

Openness describes the wholeness and complexity of an individual's psychological and experiential life [17]. According to our study results, as openness scores increase, so do perception scores for *Authoritative* persuasive technologies for likelihood of use and *Competitive* technologies for ease of use. On the contrary, as openness scores increase, perception scores for both *Extrinsic* and *Intrinsic* technologies for time saving and *Negative Reinforcement* technologies for ease of use actually decrease. This implies that individuals who display more

openness will be more likely to think that *Authoritative* technologies are something they would use in the future and *Competitive* technologies are easy to use. However, these individuals would be less likely to think that a number of different reward strategies are will save them time or would be easy to use.

### Summary

Taken together, these findings and implications can help guide future designs of mobile persuasive technology applications for different personalities. Future research can also possibly theorize and hypothesize on causes for these trends. For instance, individuals high in Extraversion are less likely to have positive perceptions on many persuasive technologies overall. This could possibly be explained by findings from personality and health psychology which suggest that individuals high in extraversion have more social support and close relationships important for coping with illness [17]. Thus, one may go on to hypothesize that they have less need for these types of persuasive technologies. More in-depth review of the literature, which is outside the scope of this paper, is needed for coherent and valid explanations and predictions based on the significant relationships between personality and perceptions of selected persuasive technologies.

### Goal 2: Perceptions of Mobile Persuasive Tech

Our second goal of this study was to gather more general perceptions of people's attitudes toward both the persuasive technologies we studied and health technologies in general. As shown in Table 2, Instruction Style, Social Feedback and Recording Input rank highest for overall perception scores, suggesting to designers the potential importance and efficacy of these persuasive technologies, as a number of other persuasive technologies have used previously [4,5]. In addition, overall scores for perceptions on ease of use were high throughout all six general persuasive technology styles. This suggests that these mobile-based persuasive technologies may indeed be a good solution to health improvement for a general population.

As the qualitative comments in Table 3 indicate, both positive and negative qualitative responses were encountered with each of the 12 personality technologies. Some relevant general ideas that may be useful for designers that came up often included the issue of cost, convenience, the tediousness of entering data every day. Another salient comment was the possibility for participants feeling upset if they did not meet their health goals. In future work, we plan to study these comments more holistically in order to create personas based on the in-depth analysis of individual participant responses to the survey. We plan to use these qualitative responses along with the detailed breakdown of five factor scores for each participant to create personas to design around.

For the overall perceptions of persuasive technology, the data in Figures 14-18 revealed some interesting trends. Figure 14 shows the trend of cell phones emerging as the leading choice for content delivery preference when using

technology to promote healthy behavior. This finding makes sense, considering prevalence of cell phones worldwide, especially in the United States and India, where most of our study participants were from. Interestingly, music players such as an iPod were listed a relatively large number of times (9x) under "Other" for content delivery mechanisms.

According to Figures 15 and 16, a majority of participants answered "no" to past use of technology to modify aspects of general behaviors, and an even larger majority of participants answered "no" to past use of technology to modify aspect of a behavior related to health. These findings indicate that persuasive technologies are still new and underutilized, and designers of health applications might want to employ more strategies to persuade first time users to try out such applications. Figure 17 depicts a rather encouraging trend indicating that a majority of participants are very likely or moderately likely to using a technology to promote healthy lifestyle in the future. Figure 18 illustrates that improving general health, improving nutrition and stress reduction are other aspects of health that participants would like to change. One should also note that losing weight was listed rather frequently (10x) in the "Other" option. Additional responses for "Other" which were each listed once included sleep and relaxation, pain management, and diabetes management. These ideas suggest potential areas for future persuasive mobile application designs.

### Limitations of the Current Study

Although we uncovered a number of interesting trends, this study was not without limitations that should be considered when interpreting these results. First and foremost, the storyboard depiction of persuasive strategies may not have been as accurate as having participants use a working prototype of the persuasive technologies. However, using storyboards represented a cost-effective way to analyze the large number of participant perceptions required for these types of studies. Recruiting through Amazon's Mechanical Turk has its own limitations, as described previously. However, these risks may be overshadowed by the benefits that AMT offered. Indeed, demographic data presented in Figure 13 illustrates that using AMT resulted in a fairly good survey distribution for residence type and country. Further, a majority of participants recruited were confident about their fluency in the English language. However, as expected, larger than average distribution of individuals aged between 22-30 were recruited, and a large majority of participants had college and graduate degrees. Finally, we acknowledge that assessing personality through the Big Five model may not necessarily explain all of human personality. It merely represents one form of personality assessment and was used because it allowed us to analyze a large number of personalities at once.

### CONCLUSIONS & FUTURE WORK

To summarize, we investigated the relationship between personality and persuasive technologies, specifically mobile based persuasive technologies that promoted healthy

lifestyles. We also investigated overall perceptions toward these persuasive technologies and the general concept of persuasive technologies. This was the first comprehensive study to investigate the relationship between the Big Five personality traits and different persuasive technology styles. We also were able to gather perceptions on persuasive technologies from a large number of users across a fairly diverse population. Although this study showed many interesting and significant findings, we believe there are many areas for future exploration remain. In a follow up study, we plan to carry out a profile analysis of selected anonymized participant responses and present the result as research for designing for personas. Furthermore, we plan to use the findings gained from this and future related studies to design mobile-based health applications that can be customized to individual personalities for maximum success across a diverse population. Upcoming projects may involve the creation of iPhone or other mobile apps that have wide and popular appeal. Overall, we believe that this study has successfully illustrated the need to design more health promoting persuasive tech which may reduce preventable deaths in the long run. Most importantly, when designing persuasive health applications that focus on preventive health strategies, researchers should always prioritize the need to personalize the application for maximum efficacy. We hope the results from this study will be useful to persuasive technology designers, especially those designing for specific populations.

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