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

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Abstract. Though a variety of persuasive health applications have been designed with a preventive standpoint toward 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 goal for this research was to explore the relationship between personality and persuasive technologies in the context of health-promoting mobile applications. We conducted an online survey with 240 participants using storyboards depicting eight different persuasive strategies, the Big Five Inventory for personality domains, and questions on perceptions of the persuasive technologies. Our results and analysis revealed a number of significant relationships between personality and the persuasive technologies we evaluated. The findings from this study can guide the development of persuasive technologies that can cater to individual personalities to improve the likelihood of their success.

Keywords: Persuasive Technologies, Personality, mHealth, User-Centered Design, Quantitative Methods.

1 Introduction

Over the past decade, we have seen a rise in technologies targeting the promotion of a healthy lifestyle [5,17,19,21,24]. It is not uncommon for individuals to have tried using their computers or mobile phones to track physical activity [4,5], moderate nutrition [24], or quit smoking (http://www.quitnet.com). Given their popularity, applications designed to promote healthy living are promising for helping users set and achieve their health-related goals, but have not yet proven themselves for long-term adoption and behavior change. Thus, more design guidance and a better understanding of how technologies can be customized to fit users' lives is needed.

Many persuasive technologies have been designed mainly for a general audience using a single persuasive technique. With this approach, it is challenging to sustain user interest over time and appeal to a broad range of people. Thus, many products which start out fairly general need to specialize over time to better cater to the needs of its users. The one-size-fits-all notion is typically not enough to meet the demands

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of users, especially with regard to health technologies. Consumers are expecting more from providers across a wide range of fields, and persuasive technologies are no exception. These technologies may better accommodate the needs of diverse users and sustain user interest over time by considering the different personality types of their users. There is some promise that applications customized for an individual's personality type may achieve higher success rates [1].

With this work, we wanted to investigate whether significant relationships exist between personality types and perceptions of persuasive technologies targeting health promotion. In our study, we focus on persuasive mobile technologies that promote physical activity, because that is one of the common applications of health and most individuals currently own a mobile device. To achieve this goal, we conducted an online survey with 240 participants using storyboards depicting eight different persuasive technology strategies: Authoritative, Non-Authoritative, Extrinsic Motivators, Intrinsic Motivators, Positive Reinforcement, Negative Reinforcement, Cooperative Social Persuasion and Competitive Social Persuasion. We used the Big Five Inventory (BFI) to assess the personality types of participants and asked them a series of questions about their perceptions of the different persuasive strategies depicted in the storyboards. Our results revealed a number of significant relationships between personality and the persuasive technologies we studied, including some personality types favoring different techniques with other personality types disliking several of the strategies. 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 and provide guidelines for the development of health promoting persuasive technologies which can be tailored to individual personalities 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 the results, provide potential explanations for the different results we discovered, and discuss the limitations of the current study. We conclude with our directions for future research.

2 Related Work

The idea of using technology to motivate desirable behaviors has recently become a popular topic within the technology design community. Originating with the definition of captology by Fogg [7], 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 [6], and the application space for persuasive technologies has been well explored. Motivating physical fitness has been one of the most common applications [4,5,17]. Other applications include motivating healthy eating habits [12,18], healthy water intake [3], sustainable transportation [8], and reduced television watching [20]. 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 and the storyboards are drawn at a high enough level that it does not encapsulate specific application details. Instead, we are outlining the ways that these applications can be customized to be more successful for users based on their personalities.

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 [11]. 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 [14]. The Big Five factors are Neuroticism, Conscientiousness, Agreeableness, Extraversion, and Openness [11]. According to psychological research [14], these are defined as follows:

- *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.

In this study, we determined how these personality domains relate to perceptions of health-promoting persuasive technologies.

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 [9] 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 [10]. Most closely related to our work is Arteaga *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 [1]. In their study, they used the Big Five factors to make 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.

3 Study Design

For this study, we chose to focus on one particular application of persuasive technology on a single form factor to reduce potential variables: encouraging physical activity through the use of mobile devices. We established a comprehensive list of different persuasive technology strategies by searching the literature on popular health promoting mobile persuasive technologies and common psychological approaches to health-related behavior modification. From this list, we selected 8 common types of persuasive strategies which could be sorted into four general approaches to persuasive technologies. Thus, each approach consisted of two specific complementary persuasive technology strategies. The eight strategies sorted into the four general approaches were:

(1) *Instruction Style*
- **Authoritative:** Uses an authoritative agent, such as a drill sergeant or strict personal trainer, to instruct the user on how to meet their fitness goals.
- **Non-Authoritative:** Uses a neutral agent, such as a friend or peer, to encourage the user to meet their goals.

(2) *Social Feedback*
- **Cooperative:** Uses the notion of users cooperating as a team with friends or peers to complete their fitness goals.
- **Competitive:** Uses a strategy of competing against friends or peers to "win" a competition.

(3) *Motivation Type*
- **Extrinsic:** Uses external motivators, such as winning trophies, as a reward for conducting healthy behaviors.
- **Intrinsic:** Uses internal motivators, such as feeling good about one's self or feeling healthy, to motivate healthy behaviors.

(4) *Reinforcement Type*
- **Negative Reinforcement:** Removes an aversive stimulus (*e.g.,* turns a brown and dying nature scene green and healthy) as the user conducts more healthy behaviors.
- **Positive Reinforcement:** Adds a positive stimulus (*e.g.,* adds flowers, butterflies, and other nice-looking elements to any empty nature scene) as the user conducts more healthy behaviors.

We represented these strategies of persuasive technologies though the use of storyboards drawn by an artist based on the design guidelines of Truong, *et al.* [23]. We chose to use storyboards because they provided a common visual language that individuals from diverse backgrounds could read and understand [16]. 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. Figure 1 shows two examples from the eight storyboards used in the study for positive reinforcement motivation type and competitive social feedback.

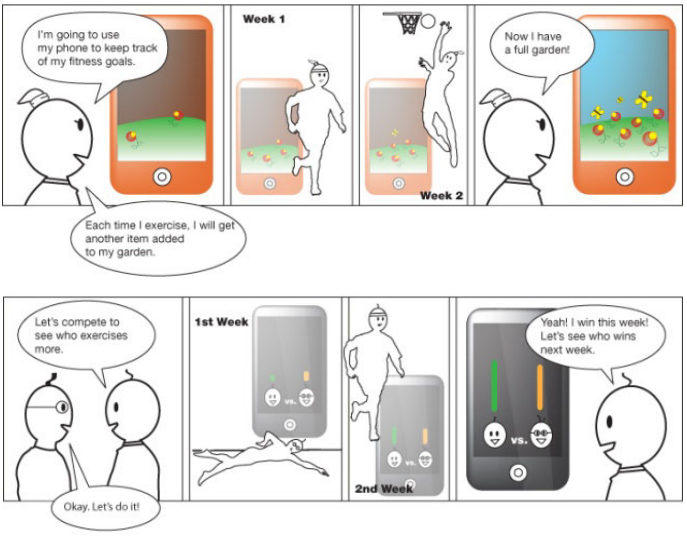

Fig. 1. Storyboards illustrating Positive Reinforcement motivation type (top) and Competitive social feedback (bottom)

3.1 Survey Design

To elicit feedback on the acceptance of the technologies depicted in the storyboards, we designed four different online surveys. The first part of the survey was designed to elicit information regarding perceptions on one of the four major 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, six of which were 5-point Likert-scale questions probing the users' opinions on the technology in terms of enjoyment, likelihood of use, helpfulness, quality of life, ease of use, and time savings, all of which are major goals of persuasive technologies. The seventh was an open-ended question about any other thoughts or comments. The seven questions are as follows:

(1) **Enjoyment:** This technology is something that I would: (5-Really enjoy using, 1-Really dislike using).
(2) **Likelihood of Use:** In the future, this technology is something I would: (5-Definitely consider using, 1-Definitely not consider using).
(3) **Helpfulness:** With regards to my own health goals, I consider this technology: (5-Very helpful, 1-Very unhelpful).
(4) **Quality of Life:** With regards to the quality of my life, I think this technology would: (5-Definitely improve the quality of my life, 1-Definitely degrade the quality of my life).
(5) **Ease of Use:** I think this technology seems: (5-Very easy to use, 1-Very difficult to use).

(6) **Time Saving**: I think using this technology would help me: (5-Definitely save me time, 1-Definitely waste my time).
(7) **General Comments:** Please describe any other comments or reactions to the technology depicted in the storyboard.

Immediately following the survey with the storyboards and the seven questions, we presented the participant with an assessment of 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 [2,13,14]. We selected this version of the BFI for its efficiency (five minutes of administration time, compared to fifteen minutes for other comparable measures) [14]. In addition, the items on the BFI are shorter and more understandable.

At the end of the survey, we presented the participant with multiple choice and open-ended questions on gender, age, educational background, size of city, county, and fluency of the English language. We then presented both storyboards from the beginning of the survey and a multiple choice question that asked the participant to describe the persuasive style used in the in the storyboards (*e.g.*, authoritative vs. non-authoritative, competitive vs. cooperative, *etc.*). 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 7-10 minutes to complete. Participants were randomly assigned to one of the four different persuasive strategy survey types.

3.2 Participant Recruitment

We recruited 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.* [15] 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 240 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.

4 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.

4.1 Storyboard Success and Data Filtering

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 ($p<.05$). Overall, these results indicate that our storyboards successfully depicted the selected persuasive technologies strategies. In addition, 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 50 out of the 240 responses being discarded (7 from the Instruction Style survey, 22 from the Social Feedback survey, 8 from the Motivation Type survey, and 13 from the Reinforcement Type survey).

4.2 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 in which they lived. Figure 2 shows 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.

Table 1. Participant demographics across all four surveys

Total Participants = 240	
Gender	Male (53.0%), Female (47.0%)
Age	21 or under (18.8%), 22-30 (37.2%), 31-40 (17.9%), 41-50 (12.6%), 61 or older (0.4%)
Education	Some High School (1.0%), High School (7.4%), Some College (19.7%), College Degree (37.5%), Some Graduate School (6.9%), Graduate Degree (33.0%), Training Certificate (0.5%)
Residency Type	Rural (15.3%), Small Town (14.9%), Suburb (33.7%), Urban (36.1%)
English Fluency	Excellent (55.7%), Good (21.2%), Moderate (8.2%), Fair (10.2%), Minimal (4.7%)
Country	United States (53.1%), India (35.9%), Pakistan (1.9%), Canada (0.8%), Other (4.2%)

4.3 Personality and Persuasive Technology 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 Pearsons Correlational tests using SPSS to determine the correlation between the scaled personality scores and the Likert-scale responses to the perceptions regarding the persuasive technologies depicted in the storyboards. We found significant correlations for all five of the personality traits we tested. Table 2 displays significant correlations ($p<.05$) grouped by personality factor. In addition, Table 2 sorts the significant correlations by persuasive technologies within each personality factor to give an overall sense of which technologies were appropriate or inappropriate for which personality types. 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.

In general, we found more negative correlations than positive correlations, indicating that our participants had a stronger sense of which technologies they would not favor compared to those that did. The personality type of Extraversion had the most correlations (12 negative, 0 positive), followed by Agreeableness (8 negative, 1 positive), Conscientiousness (0 negative, 5 positive), Openness (3 negative, 2 positive), and finally Neuroticism (1 negative, 1 positive). Our findings show that as a participant's score for Neuroticism increases, their opinions toward Cooperative strategies improving their quality of life decreases and their likelihood of enjoyment of Negative Reinforcement increases. As a participant's score for Conscientiousness increases, their opinion of the helpfulness and likelihood of use for Competitive strategies increases, as does their opinion on the helpfulness, time savings, and quality of life improvement of the Cooperative strategy. We also found that as Agreeableness scores increase, their opinion of Competitive strategies having a high ease of use increases, but opinions decrease on the enjoyment, likelihood of use, helpfulness, and quality of life improvement of the Negative Reinforcement strategy and the enjoyment, likelihood of use, quality of life, and time savings of the Positive Reinforcement strategy. For those participants whose Extraversion scores increase, their opinion decreases on the quality of life improvement, likelihood of use, and time savings of the Extrinsic persuasive strategy, the enjoyment, helpfulness, and likelihood of use of Intrinsic strategies, the enjoyment and helpfulness of Negative Reinforcement, and the ease of use, enjoyment, helpfulness, and likelihood of use of the Positive Reinforcement strategy. Finally, as participants' scores in Openness increase, so does their opinion on the likelihood of use of the Authoritative strategy and the ease of use of the Competitive strategy, but their opinion decreases on the time savings of Extrinsic and Intrinsic strategies and the ease of use of Negative Reinforcement strategies.

Table 2. Significant correlations ($p < .05$) grouped by personality factor as calculated by Pearsons Correlational Test. Negative correlations are indicated in red text, and Positive correlations are indicated in both green and bold text.

Neuroticism		
Persuasion Type	**Perception Measures**	**Pearsons R Value**
Cooperative	Quality of Life	r(47) = -.387
Negative Reinforcement	Enjoyment	r(51) = **+.299**
Conscientiousness		
Persuasion Type	**Perception Measures**	**Pearsons R Value**
Competitive	Helpfulness	r(47) = **+.293**
Competitive	Likelihood of Use	r(47) = **+.400**
Cooperative	Helpfulness	r(47) = **+.288**
Cooperative	Time Saving	r(47) = **+.339**
Cooperative	Quality of Life	r(47) = **+.314**
Agreeableness		
Persuasion Type	**Perception Measures**	**Pearsons R Value**
Competitive	Ease of Use	r(47) = **+.298**
Negative Reinforcement	Enjoyment	r(51) = -.448
Negative Reinforcement	Likelihood of Use	r(51) = -.378
Negative Reinforcement	Helpfulness	r(51) = -.377
Negative Reinforcement	Quality of Life	r(51) = -.325
Positive Reinforcement	Enjoyment	r(51) = -.343
Positive Reinforcement	Likelihood of Use	r(51) = -.318
Positive Reinforcement	Quality of Life	r(51) = -.280
Positive Reinforcement	Time Saving	r(51) = -.276
Extraversion		
Persuasion Type	**Perception Measures**	**Pearsons R Value**
Extrinsic	Quality of Life	r(58) = -.316
Extrinsic	Likelihood of Use	r(58) = -.276
Extrinsic	Time Saving	r(58) = -.296
Intrinsic	Enjoyment	r(58) = -.313
Intrinsic	Helpfulness	r(58) = -.268
Intrinsic	Likelihood of Use	r(58) = -.309
Negative Reinforcement	Enjoyment	r(51) = -.402
Negative Reinforcement	Helpfulness	r(51) = -.329
Positive Reinforcement	Ease of Use	r(51) = -.417
Positive Reinforcement	Enjoyment	r(51) = -.366
Positive Reinforcement	Helpfulness	r(51) = -.344
Positive Reinforcement	Likelihood of Use	r(51) = -.332
Openness		
Persuasion Type	**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

5 Discussion

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

5.1 Personality and Persuasive Technology Relationship

The number of correlations we found indicates that there is some promise to using personality traits as a method for adapting persuasive strategies to better fit the needs of users. Here we offer possible explanations for some of the correlations we found. Taken together, these findings and implications can help guide future designs of mobile persuasive technology applications for different personalities and give designers a better sense of which designs may work better with specific user groups. Although we attempt to provide explanations, future research is needed for valid explanations of the significant relationships.

Neuroticism describes a tendency toward negative emotionality, which can be described as feeling nervous, sad, tense, and emotional instability [14]. This trait showed the fewest correlations, which could indicate indecisiveness about the different strategies. The two correlations we found were interesting, in that there was a positive correlation toward enjoyment of Negative Reinforcement, which consisted of the transition of a dry, brown field to a lush green one. The decrease in the opinion on the quality of life for Cooperative strategies may indicate that these participants do not prefer working with others to achieve their goals.

Conscientiousness is the tendency toward goal completion, following norms and rules, planned behavior, prioritizing tasks [14]. We believe people with these traits would be most likely to be successful in achieving their health goals, and our study shows that people with higher conscientiousness scores were the most positive in general toward the technologies with five positive correlations. The correlations were all with the two Social strategies of Competitive and Cooperative. Thus, people who are conscientious may be more likely to use socially-based technologies.

Agreeableness is the tendency toward altruism, trust, and modesty as well as compassion and cooperativeness toward others [14]. Interestingly, the only positive correlation to this trait was in the ease of use of the Competitive strategy. We were surprised that we did not see any positive correlations with the Cooperative strategy, although modesty or not wanting to brag or make others feel bad may play into this. We also saw a number of negative correlations with the positive and negative reinforcement strategies. This may indicate that reinforcement systems in persuasive technologies are not as desirable for people who are agreeable.

Extraversion is the tendency for personality traits of sociability, activity, and assertiveness and an engagement with the external world [14]. There were no positive correlations for any of the technologies with regard to extraversion scores and a large number of negative correlations for a number of the different persuasive strategies. This may indicate that persuasive technologies in general are not perceived as desirable by people with high extraversion scores. This could possibly be explained by their tendency to have strong social networks and thus not have as much need for technology to meet their goals, which tends to be more personal in nature.

Openness is the tendency toward art, emotion, unique experiences, and the wholeness and complexity of an individual's life [14]. Our study showed that individuals with higher openness scores were more likely to favor Competitive or

Authoritative technologies. This could be because these are technologies that they have not yet tried, and thus it would be a new experience.

5.2 Limitations of the Current Study

Although we uncovered a number of interesting trends, this study was not without limitations to consider when interpreting these results. First, given that previous researchers have shown that different prototype formats can results in different user feedback, it is important to further study these findings with working prototype or other types of depictions such as videos [22]. Recruiting through Amazon's Mechanical Turk has its own limitations, as described previously. However, these limitations may be balanced by the benefits that AMT offered. The demographic data presented in Table 1 illustrates that using AMT resulted in a fairly good survey distribution for a number of criteria. However, as expected, AMT recruited a larger than average distribution of individuals aged 22-30 and with 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.

6 Conclusions and Future Work

We investigated the relationship between personality and persuasive technologies, specifically mobile based persuasive technologies that promoted healthy lifestyles. This was the first comprehensive study to investigate the relationship between the Big Five personality traits and different persuasive technology strategies. Although this study showed many interesting and significant findings, we believe there are many areas for future exploration. We will further analyze our dataset by looking at combinations of personality types (*e.g.,* whether there are preferences in technology for people who are high in both Agreeableness and Extraversion), a regression analysis of the findings, and the qualitative statements made about the perceptions of persuasive technologies and general attitudes toward persuasive technologies by personality type. Follow up studies could include comparisons of perceptions of persuasive technology strategies with other similar psychological tests, such as tests for optimism. We plan to use the findings to design mobile-based health applications that can be customized to individual personalities for maximum success across a diverse population. Overall, we believe this study has successfully illustrated the promise of customized persuasion techniques based on personality. We hope the results from this study will be useful to persuasive technology designers, especially those designing for specific populations.

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