Towards Personality-driven Persuasive Health Games and Gamified Systems

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ABSTRACT

Persuasive games and gamified systems are effective tools for motivating behavior change using various persuasive strategies. Research has shown that tailoring these systems can increase their efficacy. However, there is little knowledge on how game-based persuasive systems can be tailored to individuals of various personality traits. To advance research in this area, we conducted a large-scale study of 660 participants to investigate how different personalities respond to various persuasive strategies that are used in persuasive health games and gamified systems. Our results reveal that people's personality traits play a significant role in the perceived persuasiveness of different strategies. Conscientious people tend to be motivated by *goal setting*, *simulation*, *self-monitoring and feedback*; people who are more open to experience are more likely to be demotivated by *rewards*, *competition*, *comparison*, and *cooperation*. We contribute to the CHI community by offering design guidelines for tailoring persuasive games and gamified designs to a particular group of personalities.

Author Keywords

Persuasive game; personality; personalization; persuasive strategies; gamified design; behavior change; risky health behavior; serious games.

ACM Classification Keywords

H.5.m. Information interfaces and presentation (e.g., HCI): Miscellaneous. K.8.0 Games

INTRODUCTION

There is growing evidence that persuasive games and gamified systems are effective tools for motivating behavior change, influencing people, and promoting learning using various persuasive strategies [24,25,51]. Therefore, designing digital games for purposes other than entertainment has been a focus for many HCI and game researchers[18,52]. Persuasive games and gamified systems for *health*—which are designed as interventions with the primary purpose of changing a user's behavior or attitude

[16,50] have attracted the attention of researchers, physicians, and health practitioners. Research has shown that persuasive games and gamified systems can be strategically designed to motivate desirable behavior change; for example, to help people overcome addictive behaviors such as substance abuse [28,29,37], promote personal wellness, manage diseases, engage in preventive behaviors [13,20,50] and avoid risky behaviors [28–30,61].

Despite this growing interest and investment in persuasive games and gamified systems, current persuasive games suffer a major limitation: Most persuasive games adopt a non-tailored approach to their design [27]. However, recent research shows that this approach may not be effective because different types of people are motivated by different persuasive strategies [48,50], and a persuasive strategy that worked well with one group of people may demotivate a different group [10,35,50]. Consequently, there is an increasing demand for persuasive games, especially those targeted at health behaviors to be tailored to the target users' motivation   [6,50,53]. Research has shown that tailoring persuasive games and gamified systems can increase their efficacy in motivating the desired behavior change compared to the non-tailored systems [49]. However, there is little knowledge about how persuasive games and gamified systems can be tailored to individuals of various personality traits. Personality has been shown to play significant roles in many areas of Human-Computer Interaction (HCI) including user interface design [45], persuasive messages [23,26], and gamification [32,62].

To investigate how to tailor persuasive games and gamified systems, we conducted a large-scale study of 660 participants that examined how people of different personalities (as identified by the Big-Five Personality [57]) respond to various persuasive strategies (*competition*, *simulation*, *self-monitoring and feedback, goal setting and suggestion*, *customization*, *reward, social comparison*, *cooperation*, *punishment*, and *personalization* [21]) that are widely used in persuasive health games and gamified systems. We employed Structural Equation Modeling [58] to develop models showing how people of different personalities respond to or prefer various persuasive strategies represented in storyboards. Our results reveal that people's personality traits play a significant role in the perceived persuasiveness of different strategies. For example, conscientious people tend to be motivated by *goal setting*, *simulation*, *self-monitoring*, and *feedback*; people

who are more open to experience (openness) are more likely to be demotivated by *rewards*, *competition*, *comparison*, and *cooperation*. The results highlight the need to tailor persuasive games and gamified systems based on people's personality. Our findings can help designers to make decisions about which persuasive strategy to use and which to avoid when designing persuasive games and gamified systems that are targeting people of different personalities.

Our work offers two main contributions to the field of gameful design and persuasive design in HCI. First, we show the importance of *tailoring* persuasive games and gamified systems by revealing that people of divergent personalities respond differently to dissimilar persuasive strategies. Second, we validate and compare the perceived effectiveness of individual strategies and show that the strategies differ significantly in their overall effectiveness for motivating risky health behavior change. Based on our findings, we offer design guidelines for persuasive games and gamified systems that appeal to both a broad audience and a particular group of personalities.

RELATED WORK
In this section, we present a brief overview of persuasive strategies and game-based interventions employing the strategies. We conclude with a summary of research efforts toward tailoring persuasive games for health.

Persuasive Strategies
A fundamental feature of persuasive games and gamified systems is persuasion, an attempt to influence or reinforce behaviors, attitudes, feelings, or thoughts [16]. Persuasion is often achieved using various persuasive strategies. Persuasive strategies are techniques that can be employed in persuasive games and gamified systems design to promote desirable behaviors or attitudes. Over the years, a number of persuasive strategies have been developed. For example, Fogg [8] developed seven persuasive strategies, and Oinas-Kukkonen [21] developed 28 persuasive strategies.

According to the previous studies, *Competition*, *Simulation*, *Self-monitoring and Feedback*, *Goal Setting and Suggestion*, *Customization*, *Reward*, *Social Comparison*, *Cooperation*, *Punishment*, and *Personalization* are the 10 commonly employed strategies in persuasive games and gamified systems design [40,53], see Table 1.

Persuasive Games and Gamified Interventions.
Researchers have designed and applied games as digital interventions in many domains including binge drinking prevention [28,29,37], drug and substance use prevention [38], smoking cessation [36], energy conservation [4], healthy eating [1,49,52], and physical activity [6,17]. Among all the domains of applications, the use of persuasive games and gamified systems in the health domain has received special attention. The definitions of the persuasive strategies is presented in Table 1.

Several persuasive games and gamified systems have employed the persuasive strategies highlighted above to

Competition: Allows users to compete with each other to perform the desired behavior.
Simulation: Provides the means for a user to observe the cause-and-effect linkage of their behavior.
Self-monitoring and Feedback: Allows people to track their own behaviors, providing information on both past and current states.
Goal Setting and Suggestion: Requires users to set a clear behavior goal and recommend certain actions (for achieving the desired goal to users during system use).
Customization: Provides users an opportunity to adapt a system's content and functionality to their needs and choices
Reward: Offers virtual rewards to users for performing the target behavior.
Comparison: Provides a means for the user to view and compare their performance with the performance of other user(s).
Cooperation: Requires users to cooperate (work together) to achieve a shared objective and rewards them for achieving their goals collectively.
Personalization: Offers system-tailored contents and service to its users, tailoring content and functionality to a particular user's need based on a user's characteristics.
Punishment: Penalizes the user for not performing the desired behavior or reaching their goal (such as removing acquired rewards, other cherished possessions from the user.)

Table 1: Definitions of the persuasive strategies

motivate risky health behavior change. For example, *N-Squad Web Adventure* [37] is a role-playing game employing *reward*, *simulation*, *personalization*, and *cooperation* to impact knowledge about the consequences of alcohol consumption and hence discourage risky drinking behaviors. The game simulated the consequences of alcohol intake and reflected its impact on the digestive, circulatory, and nervous systems: *simulation*. To increase relevance, players are presented with a tailored effect of alcohol on young adults of their age: *personalization*. The game requires that players work as part of a team to resolve the game challenge: *cooperation*. Finally, to incentivize players, they receive points for correct responses to the game quizzes: *reward*. For a detailed review of persuasive strategies and how they are employed in alcohol and other risky health behavior see Lehto and Oinas-Kukkonen [40].

Despite these past studies there is still little knowledge about the efficacy of individual strategies and how the strategies can be tailored to people of different personalities. Our study fills this gap.

Personality Theory and HCI
Over the years, researchers have attempted to develop models for assessing and classifying individuals into various personality types. Among them is the Big Five Factor Model (FFM) of personality [19]. The FFM is currently the leading and most widely accepted model of personality because it establishes a common taxonomy that

is capable of predicting variance in individuals' behaviors, thoughts, feelings, and actions [43]. The FFM highlights five personality traits: *Extraversion*, *Openness*, *Neuroticism*, *Conscientiousness, Agreeableness,* and see Table 2. The FFM has been used by several HCI and game researchers, e.g., to understand gameplay motivation [31,33,54] and game preference [56,65]; to understand the effect of different game controller [7], game elements [32], and need fulfillment in an online game.

Despite this wide adoption of personality traits by HCI researchers, there is limited research on how to tailor persuasive technologies and persuasive games in particular to various personalities. Hirsh et al. [26] examined whether the effectiveness of persuasive messages could be increased by tailoring the message to the recipient's personality. Their results suggested that tailoring persuasive messages to the FFM was an effective way of increasing the effectiveness. Along these lines, Arteaga et al. [3] tailored persuasive mobile games to various users' personalities. User's personality information was used to inform the choice of game recommended to the users. Arteaga's study suggests some possible relationships between personality traits and persuasive games preference [2] and hence, the need for further exploratory study into the relationships.

Traits	The five traits represent the tendency to…
Extraversion	… be outgoing, expressiveness, seek out new opportunities, and ambitious
Conscientiousness	…be self-discipline, actively plan, goal-oriented, dependable, and organized
Openness	…be curious, imaginative, hold unconventional values, and creative
Agreeableness	…be considerate, cooperative, tolerant, friendly, caring, and helpful
Neuroticism	…be nervous, fearful, sensitive, distrustful, and emotionally unstable

Table 2. Definition of the Big Five factors personality

STUDY DESIGN AND METHODS

Our study was designed to investigate the relations between the FFM personalities (*openness*, *conscientiousness*, *extraversion*, *agreeableness*, and *neuroticism* [57]) and perceived persuasiveness of the 10 strategies (*customization*, *simulation*, *self-monitoring and feedback*, *goal-setting and suggestion*, *personalization*, *simulation*, *punishment*, *reward*, *comparison*, *competition*, and *cooperation*) for motivating change in risky healthy behavior (especially change of unhealthy alcohol behavior).

Measurement Instrument

To collect data for our study, we follow the approach described in our earlier study [53] which investigated the appeal of persuasive strategies to various gamer types and found that the persuasiveness of the strategies vary depending on the gamer type. Specifically, we represented

each persuasive strategy in a storyboard about a persuasive game for promoting change of unhealthy alcohol behaviors. The 10 storyboards were drawn by an artist and were based on storyboard design guidelines by Truong et al. [64]. Implementing the strategies in storyboards makes it easier to elicit responses from diverse populations because storyboards provide a common visual language that individuals from diverse backgrounds can read and understand [41]. Storyboards have been shown to be effective at depicting strategies in previous research [9,53]. The storyboards show a character and their interactions with gamified persuasive systems for promoting change of unhealthy alcohol behavior. We evaluated and iteratively refined the storyboards following three expert discussions: the first two with HCI and persuasive technology experts and the last one with an expert in rhetoric and narrative in games. After the expert evaluations, we conducted an online user evaluation of 10 participants with the sole purpose of ensuring that our storyboards accurately depicted the strategies. The user evaluation led to some minor refinements. Figure 1 shows an example of one of the storyboards illustrating the reward strategy. All the storyboards can be found in the supplementary material.

To elicit feedback on the persuasiveness of the strategies, each storyboard was followed by a validated scale for assessing perceived persuasiveness. The scale was adapted from Drozd et al. [15] and has been used in other persuasive research investigations [9,49,53]. The scale consists of four questions: i) *"The system would influence me."*; ii) *"The system would be convincing.";* iii) *"The system would be personally relevant for me."*; iv)*"The system would make me reconsider my alcohol drinking habits."* The questions were measured using participant agreement with a 7-point Likert scale ranging from "1 = Strongly disagree" to "7 = Strongly agree". We included an open-ended question allowing participants to provide comments to justify their ratings of each strategy. Prior to assessing the persuasiveness of the strategies, we ensured that the participants understood the strategy depicted in each storyboard by asking them two comprehension questions— first, to identify the illustrated strategy from a list of 10 different strategies (*"What strategy does this storyboard represent"*); and second, to describe what is happening in the storyboard in their own words (*"In your own words, please describe what is happening in this storyboard"*). We also included 10-item personality inventory for assessing the FFM personality traits [57]; questions for assessing the participants' demographic information, and drinking behavior were also included.

Data Collection

We recruited participants for this study using Amazon's Mechanical Turk (AMT). We used AMT for two main reasons: First, AMT has become an accepted method of gathering users' responses [26,32,53]; and secondly, we needed a large participant sample and diverse audience for our study. AMT allows access to a global audience at a
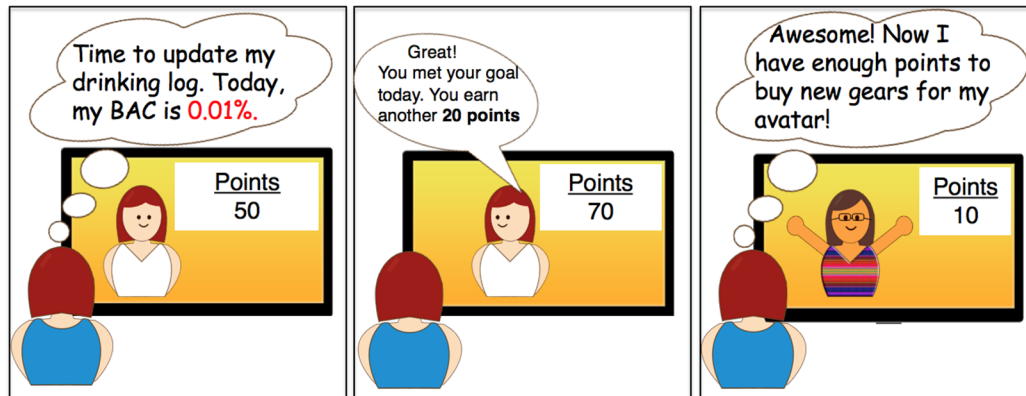
Figure 1: Storyboard illustrating the *Reward* persuasive strategies

relatively low cost, and ensures efficient survey distribution, and high quality results [8,44].

To eliminate possible bias due to the ordering of the storyboards we used the page randomization functionality provided by SurveyMonkey which rotates the position of the storyboard and varies their ordering for each participant. Before the main study, we conducted two pilot studies. The first pilot study was conducted on 10 random students recruited from a Canadian University and the second on 10 participants from AMT to test the validity of our study instruments.

Participants' Demographic Information
A total of 660 responses was included in this analysis, after filtering out incomplete responses and incorrect responses to comprehension and attention-determining questions [44]. All our participants were at least 15 years of age at the time of data collection, consumed or had consumed alcohol at some time, and read and understand English well. The participants received a small monetary compensation in compliance with the study ethics approval. In general, we had a relatively diverse population in terms of gender, age, education level attained, see Table 3. Our participants came from the USA, India, Canada, Mexico, and other countries.

DATA ANALYSIS
The main aim of this paper is to examine the relations between the FFM personality traits and the persuasiveness of 10 commonly employed persuasive game design strategies. To achieve this, we used several well-known analytical tools and procedures. We summarize the various steps taken to analyze our data in this section.

1. We validated that our storyboards correctly depicted the intended strategy using a chi-squared test [23].
2. We determined the suitability of our data for analysis using the Kaiser-Meyer-Olkin (KMO) sampling adequacies and the Bartlett Test of Sphericity [34].
3. To examine and compare the persuasiveness of the strategies, we computed the average score for each strategy and conducted a Repeated-Measure ANOVA (RM-ANOVA) followed by pairwise comparison, after validating for the ANOVA assumptions.

Total Participants = 660	
Gender	Females (51%), Males (48%), Trans* (1%), Others (0%).
Age	15-25 (23%), 26-35 (41%), 36-45 (22%), Over 45 (14%).
Education	Less than high school (1%), High school graduate (23%), College diploma (12%), Bachelor's degree (40%), Master's degree (20%), Doctorate degree (2%), Others (2%).
Ethnicity	Black/Non-Hispanic (7%), Native American/American Indian (1%), Asian/Pacific Islander (19%), Hispanic (7%), Caucasian (64%), Multi-Ethnic (2%).

Table 3: Participants' demographic information

4. Next, we employed the Partial Least Square (PLS) Structural Equation Modeling (SEM) (PLS-SEM) [58] to create models showing the relations between the personality traits and the persuasiveness of the strategies, Figure 2. SEM is a recommended approach for modeling of relationships between variables [39]. Specifically, we used SmartPLS 3 [58].

Storyboard Validation
To ensure that participants understood the strategy depicted in each of the storyboards, we ran chi-squared tests on the participants' responses to the multiple-choice questions that required them to identify the represented strategy for each of the storyboards. The results for all the strategies were significant at $p < 0.01$, which indicates that the storyboards were understood by the participants and that the storyboards successfully depicted the intended persuasive strategies[53].

Measurement Validation
We determined the suitability of our data for further analysis using the Kaiser-Meyer-Olkin (KMO) sampling adequacies and the Bartlett Test of Sphericity. Our results showed that the KMO was 0.966, well above the recommended value of 0.6. The Bartlett Test of Sphericity was statistically significant ($\chi^2 (780)=40073.2$, $p < 0.0001$). These results show that our data were suitable for further analysis [39, 45].

We report here the common set of indices for model validity and reliability in PLS-SEM. Indicator reliability can be assumed because Cronbach's α and the composite reliability that analyze the strength of each indicator are all higher than their threshold value of 0.7 [11]. The data was checked for both convergent and discriminate validity and all the required criteria for the PLS-SEM validity and reliability were satisfied. All constructs have an AVE (which represents the average variance extracted by the variables from its indicator items) above the recommended threshold of 0.5 [11]. The heterotrait-monotrait ratio of correlations (HTMT) were all below the recommended limit of 0.9. The measurement models yielded an acceptable value of all indices for PLS-SEM model validity or reliability.
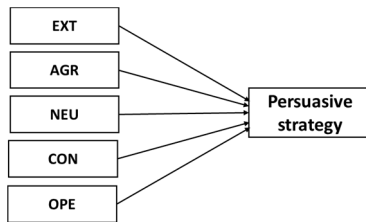
Figure 2: PLS-SEM model structure

RESULTS

In this section, we first present the results showing and comparing the overall persuasiveness of the strategies, this is followed by the results showing the relationship between the five FFM personality traits and the strategies.

Comparing the Persuasiveness of the Strategies Overall

The results of the RM-ANOVA show significant main effects of strategy type ($F_{7.37, 4852.224} = 62.535$, $p \approx .000$) on persuasiveness. This means that there are significant differences between the strategies with respect to their persuasiveness overall. In general, *Personalization*, *Simulation*, *Goal Setting* and *Suggestion*, *Self-monitoring* and *Feedback*, and *Social Comparison* (listed in decreasing order of persuasiveness) emerged as the most persuasive of all the strategies (significantly different from other strategies as shown by the Bonferonni-corrected pairwise comparisons). Our participants have least preference for *Punishment* and *Customization* (also significantly different from all others). The rest of the strategies (*Competition*, *Cooperation*, and *Reward*) were in the middle, with *Competition* leading the group. Figure 3 shows the notch boxplots of the strategies. The notch represents the 95% confidence interval of the median. In general, our participants perceived *Personalization*, *Goal Setting* and *Suggestion*, *Self-monitoring* and *Feedback*, and *Social Comparison*, *Competition*, and *Cooperation* as persuasive, with persuasiveness score significantly higher than neutral median rating of 4 ($p<.001$), indicated by the horizontal line in Figure 2. *Punishment* has significantly lower persuasiveness score than the neutral rating, (see Figure 2).

The Structural Model

The structural models determine the relations between the people's personality traits and the persuasiveness of individual strategies, Figure 2. An important criterion to

measure the strength of relationships between variables in structural models is to calculate the level of the path coefficient (β) and the significance of the path coefficient (p) [22]. Path coefficients measure the influence of a variable on another. The individual path coefficients (β) and their corresponding level of significance (p) obtained from our models are summarized in Table 4.
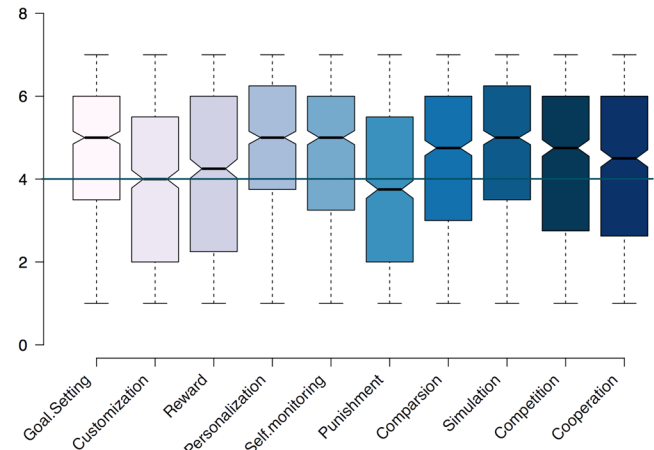
Figure 3: A boxplot showing the overall persuasiveness (y-axis) of the 10 persuasive strategies on a scale ranging from 1 to 7. Higher numbers indicate higher persuasiveness. The horizontal line indicates a neutral rating of 4.

Factors	EXT	AGR	NEU	CON	OPE
Personalization	**.14**	.10	-	.11	.10
Cooperation	.12	**.19**	-	-	**-.12**
Simulation	.11	**.14**	-	.15	-
Self-monitoring and Feedback	**.14**	.12	-	.09	-.09
Comparison	**.18**	.12	-	-	**-.13**
Punishment	**.15**	**.19**	-	-	-.09
Goal Setting and Suggestion	**.16**	-	-	**.16**	-
Customization	.10	**.14**	-	-	-.12
Competition	**.15**	**.14**	-	-	**-.14**
Reward	**.14**	**.15**	-	-	**-.13**
EXT = Extraversion, AGR = Agreeableness, NEU = Neuroticism, CON = Conscientiousness, OPE= Openness					

Table 4. Standardized path coefficients and significance of the relationships. Bolded coefficients are p<.001, non-bolded are p<.05, and '-' represents non-significant coefficients.

Relationships between Personality Traits and Persuasive Strategies

The results from the structural model show that people's personalities influence the persuasiveness of individual strategies, Table 4. In this section, we discuss and compare the persuasiveness of the strategies for people of different personality traits.

Competition

The *competition* strategy, which leverages the power of social influence, builds on the assumption that most people are competitive and would strive to outperform their

opponents [47]. Persuasive games and gamified systems designers believe that providing means for users to compete with other users would motivate them to perform the desired behavior [16]. Our results however show that *competition* is likely to motivate behavior only for people who are high in extraversion, agreeableness, and who are less open to experience (β=.15, p<.001), (β= .14, p<.001), (β= -.14, p<.001) respectively. These findings are supported by qualitative comments from the participants to justify their ratings. For example, participants who are high in extraversion and agreeableness have this to say about the competition strategy:

*"I am highly competitive, this is a good strategy to **motivate me and keep me committed"[1]** [P51]. **"Winning gives a great feeling of accomplishment!**" [P80].*

The findings suggest that participants are motivated by competition because it *challenges them, makes them committed,* and *gives a feeling of accomplishment*. On the other hand, competition could demotivate behavior for people who are more open to experience (openness) (β= -.14, p<.001) and could have no significant impact on people who are high in neuroticism and conscientiousness. Some of the reasons given for the low preference for competition for this group include its *tendency to discourage* and *stress people*:

"*I do not like the competition aspect of this system, I think it could be very **discouraging** if you are constantly on the **losing** end"* [P519]. **"***Interesting idea for competitive people, though I think that this would be **stressful** for me"* [P12].

Other reasons against competition are that participants may feel that living a healthy lifestyle is a personal goal and should not be turned into competition as illustrated by the comment, *"Living a healthy life is a **personal goal**. One's personal use of alcohol cannot be in competition with another person's. It is a competition against oneself. Competing to improve to be better than my previous self should be the strategy"* [P6]. The result is in line with previous research that found that users were uncomfortable with using competition to motivate healthy behavior [21,63], and may even become demotivated if they lose [5].

Personalization and Customization

Personalization and **Customization** represent two different methods of tailoring systems [53]. *Customization* is often user-controlled while *personalization* is mostly system-controlled. It has been argued that tailoring is more effective if users are allowed to do it for themselves, because it imbues users with a strong sense of personal agency and control, by allowing them to individualize their preference or request compared to when users are provided with automatic system-tailored contents [53,60]. Our results show that these two strategies are perceived differently by our participants. *Customization* is preferred by people with

higher levels of extraversion and agreeableness (β=.10, p<.01) and (β= .14, p<.001) respectively, while it is perceived as negative by people who are high in openness (β= -.12, p<.01) (see Table 4). Some of reasons for the high preference for customization from the comments include the fact *that it increases system relevance, user confidence in the system, gives sense of personal touch, gives sense of freedom and control,* and *makes people feel connected to the system*, as shown:

*"Customization is good to make the **system relevant** to me"* [P25]. *"Because I customized it, I have more **confidence** on its efficacy"* [P255]. *"It would be cool to have a **personal touch** to the system…"* [P18]. *"Customization could help to make people **feel more connected** to the system"* [P75]. *"It gives me **freedom** and **control**"* [P29].

Some reasons given to justify the low preference for customization include it not being directly helpful in achieving behavior and that customization is difficult:

*"Customization is **not important** for me at all, it doesn't help me achieve the good behavior"* [P201]. *"I sometimes find customizing **difficult** to do…"* [P39].

On the other hand, *personalization* is a significant motivator for all the personality traits except for people who are emotionally unstable (neuroticism) that shows no significant association. As shown in Table 4, extraversion, agreeableness, conscientiousness, and openness perceive personalization as positive (β=.14, p<.001), (β=.10, p<.05), (β=.11, p<.01), and (β= 10, p<.05) respectively. In fact, personalization is the only strategy that is positively associated with people who are more open to experience.

Some reasons given to justify the high preference for personalization include its potential to make the system less abstract; increase users' confidence in their ability; and provide more relevant and helpful contents:

*"The good thing is that it is **less abstract**"* [P13]. *"The information is based on me, it's far more **useful**"* [61]. *"I like this feature a lot. Assuming I'm already motivated, the personalized practicable information on the amount I could drink would be very **helpful**, and increase my **confidence** that I could change my behavior"* [P394].

The last comment from P394 suggests that personalization is useful but may work better for people who are already motivated and therefore should be used alongside other motivational strategies. This is also supported by other comments: *"Personalization is very **helpful**, but would need to be paired with some form of reinforcement to be effective…"* [P16]. *"It's a great concept, pretty convincing, but could be **boring** if used alone"* [P503].

Cooperation

"A system can motivate users to adopt a target behavior by leveraging human beings' natural drive to co-operate."[46] Our results show that *cooperation* is a significant motivator for people high in agreeableness and extraversion, and those who are less open to experience (β= .19, p<.001), (β= .12, p<.01), (β= -.12, p<.01) respectively. Some reasons for

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[1] Quotes from participants are included verbatim throughout the paper, including spelling and grammatical mistakes.

this high preference for cooperation include its potential to provide *opportunities for people to stay accountable, responsible, offer mutual help and encouragement,* and *make friends*, as can be seen from the sample comments:

*"I would be motivated because I'll be **harming** someone else if I miss my goal, not just myself"* [1]. *"I would **enjoy helping** another person reach their goals. It would be a positive experience for me that would boost my own efforts"* [P205]. *"The **buddying** idea is much more powerful than the competition idea"* [P69]. *"It's easier to meet goals when you're held **accountable** by others or you know others are checking your progress"* [9].

On the other hand, cooperation is not a significant motivator for high conscientious and emotionally unstable people. Some of the reasons for this low preference include *the tendency of cooperation to create unnecessarily tension, be tedious, stressful,* and *to possibly jeopardize relationships and privacy:*

*"It would be **tedious** for me to convince someone, I would rather work on my own personal goals"* [P357]. *"It can create **tension** between people and create opportunity for **negative criticism**"* [P56]. *"It would not work for me; I'd get upset with my friend if he fails! I may not want to **risk my relationship** him"* [P19]. *"...I may not use it because it seems like an **invasion of privacy"** [P78].

Simulation

An application can motivate people to change their behavior by providing a way for people to observe the cause and effect linkage of their behaviors[16]. In line with this assumption, our results show that *simulation* is one of the strategies that is not perceived by people with any personality trait as negative. Specifically, simulation is a significant motivator for people who are high in conscientiousness, agreeableness, and extraversion (β= .15, p<.001), (β= .14, p<.001), and (β= .11, p<.01) respectively. Some reasons given to justify this high preference for simulation include that it offers users' the opportunity to see short and long-term consequences of their behaviors, it is simple, and provides concrete and realistic information as can be seen from sample comments:

*"Allowing me to see the **short** and **long-term consequences** of heavy drinking is very educational, it'll motivate me"* [P3]. *"This's the best! It takes me on a step by step journey of alcohol consumption and the possible **repercussions in long and short term"** [P209]. *"I like that this app actually shows some **concrete risks** about what can happen if I continue to drink like I have been. It's **real**"* [P603].

Simulation is not a significant motivator for people who are high in neuroticism and openness. Some reasons for the low preference for simulation is its tendency to scare people by showing them the consequences of their behaviors.

*"It might deter people who are more susceptible to **fear** factor of behaviors"* [P625]. *"The application shows real-life consequences and it's **frightening**..."* *"It makes me feel **crappy** and **scared"** [P127].

Self-monitoring and Feedback

This strategy builds on the human needs for awareness. Our results show that *self-monitoring and feedback* is significantly associated with all personality traits (although to different degrees and direction) except for people who are high in neuroticism. Self-monitoring and feedback isa significant motivator for people who are high in extraversion, agreeableness, conscientiousness, and for people who are less open to experience (β= .14, p<.001), (β= .12, p<.01), (β= .09, p<.05), and (β= -.09, p<.05) respectively. Some reasons given to justify the high preference for self-monitoring and feedback include that it is engaging, offers useful feedback, and could guide users and allow them compare progress:

*"I like that I would be able to see my past behavior and **get feedback** on how I can do better in the future"* [P78]. *"Keeping track of behavior is **engaging**. The best strategy!"* [P315]. *"Being able to **view** and **compare progression** from day to day is a greater motivator"* [P241]. *"It's a good idea, there would probably need to be some sort of **positive reinforcement** to engage people"*[P4]. The main negative comment against self-monitoring and feedback strategy is its *tendency to be tedious*:

*"User tracking would be **tedious** and not **fun** without rewards. Ideally I would like to see some way to easily track alcohol intake with a wearable device"* [P641].

The last two comments suggest that self-monitoring and feedback should be used alongside other strategies such as rewards to incentivize users and motivate behavior.

Social Comparison

Social Comparison provides an opportunity for users to view and compare their performance with the performance of other users. Unlike competition, social comparison does not involve an overt competition since there is no winning or losing involved. Our results show that social comparison is a significant motivator for people high in extraversion, agreeableness, and for people that are less open to experience (β= .18, p<.001), (β= .12, p<.01), and (β= -.13, p<.001) respectively. Some reasons given to justify this high preference include:

"I think a little comparison could help me by not wanting my friends to see that I am drinking more than them along with giving me good milestones" [P529]. *"I would really **prefer a subtle comparison** with my friends than making it a competition "*[P235].

Social comparison is not a significant motivator for people with high level of neuroticism and conscientiousness and could demotivate people who are open to experience. The main negative comment against social comparison is its tendency to be *invasive, backfire, reduce self-confidence, and interfere with an individual's privacy:*

*"Seems a bit **invasive** to have your performance displayed for all your friends to see. As a comparison method, I would prefer to compare my average overall daily performance, not my friends - keep it **private!"** [P471]. *"This type of*

*game could go **both ways**...if I drink less than my friends, it may make me drink more. So it basically comes down to what type of friends one is comparing with and if they promote drinking or not"* [P394]. *"It's not relevant to me due to not having a social circle, and due to prior addiction I think **shame** and **depression** would kick in more. I will lose my **confidence**"* [P68].

Goal Setting and Suggestion

In line with the goal setting theory[42], the ***Goal setting*** and ***Suggestion*** strategy requires users to set a goal or target performance and recommend certain behaviors (for achieving the desired goal to users during system use). Our results show that goal setting is a significant motivator for people high in extraversion and conscientiousness (β= .16, p<.001) and (β= .16, p<.001) respectively. Some reasons given to justify this high preference score include the fact that it *provides useful information* and *challenges people*:

*"I like setting goals, because I **strive** to reach them. I also like that it **advise**s and **encourage** me to keep moving forward the next day"* [P41]. *"Not as fun, however it has **useful information** and make me to really **challenge** myself in a good way. It may work **better with incentives**, doesn't have to be tangible, a badge or ranking system would likely do. If not, it would be useful for people who are motivated already"* [P208]. *"Goal setting is great, however without any true **incentive** to meet my goals, I would not worry quite as much about whether I actually met them"* [P411].

The last two comments suggest that goal setting and suggestion, similar to personalization, self-monitoring and feedback should be used alongside other incentive-oriented strategies such as rewards and competition to engage users and motivate behavior change.

Reward

In line with the reinforcement theory [59], our results show that participants high in agreeableness, extraversion, and those who are less open to experience found reward as a significant motivator (β= .15, p<.001), (β= .14, p<.001), and (β= -.13, p<.001) respectively. Some reasons given to justify this high preference score include that *it provides additional incentive, and it is fun* and *appealing*:

*"Well, being able to quit alcohol is a reward by itself but getting an **additional reward** sounds even better"* [P257]. *"I am a big fan of playing games that give the points that you can use for in-game purchases. This kind of system would be **very appealing** to me"* [P311]. *"It is **fun** to be rewarded"* [P515].

Reward is not a significant motivator for people high in neuroticism and conscientiousness. Some explanations to justify the low preference for reward include its tendency to *trivialize the benefit of behavior* and *that it is childish*:

*"...why should someone turn a **serious issue** with health consequences into a game by offering rewards?"* [P6]. *"Childish, it seems geared toward really young people"* [P8]. *"The rewards would have to be **immediate** and really **worthwhile** like being able to cash those points in for things*

like an Amazon Gift Card, payment to PayPal account, or a free meal to a restaurant to motivate" [P300].

This last comment suggests that the motivational appeal of reward could be dependent on what the reward is worth. This supports previous research that suggests that using reward as an incentive to motivate behavior may redirect the intention of a particular activity [12].

Punishment

In contrast to rewards, some persuasive games and gamified system offer some kind of ***punishment*** (for not performing the behavior) to reinforce desired behaviors. Although it has been suggested that punishment might not be as effective for motivating behavior change as reward [14], our results show however that punishment is a significant motivator for people high in agreeableness, extraversion, and for people who are less open to experience (β= .19, p<.001), (β= .15, p<.001), and (β= -.09, p<.05) respectively. Some reasons given to justify this high preference include the potential of punishment to *be fun, challenging, engaging, encouraging,* and *to reveal some consequences*.

*"I enjoy this sort of game; the risks of losing stuff would encourage me to do well. It would be **fun** and **challenging**"* [P19]. *"This would be very beneficial to me as I do not like **disappointing** others, especially myself"* [P508]. *"I will be always up for reaching goals to avoid being punished. Great, this system is more **engaging**"* [P615]

Punishment is not a significant motivator for people high in neuroticism and conscientiousness traits. Some reasons to justify their low preference for punishment include its perception as being *awful, silly, childish, discouraging, depressing, boring, harsh,* and *demoralizing*.

*"It seems a little **harsh**"* [P93], *"This is a bit **childish**"* [P4]. *"Seems **silly** to punish"* [P18], *"This is **awful**"* [P432]. *"This system **creates negativity** which is not a good way of encouraging a positive type of behavior..."* [P41].

Summary of Personality and Persuasive Strategies

In summary, extraversion and agreeableness emerged as the personality traits that are most responsive to the persuasive strategies overall. Openness and neuroticism emerged as the least responsive, with openness being negatively associated with most of the strategies while neuroticism shows no significant relation with any of the strategies.

DISCUSSION

In this section, we discuss how our findings can be applied in designing persuasive games and gamified systems to appeal to both a broader audience and to be tailored to a particular user group based on their personality.

Designing to Appeal to a Broad Audience

Our results show that *personalization* is the most persuasive of all the strategies. It is perceived as positive by all the personalities (extraversion, agreeableness, openness, and conscientiousness) except neuroticism. However, it does not negatively influence neuroticism. Therefore, to appeal to a broad user population, persuasive games and gamified

systems **should tailor their contents (using automated system tailoring as opposed to user customization) to an individual's preference**. Game elements such as *cascading information theory*, *epic meaning*, and *privacy*[2] could be used to create a sense of personalized contents and personal relevance. There are ways that personalization can be deployed as a general strategy. For example, including the participant's name in system messages or considering general color preferences for cultural or age groups [53].

Similarly, *simulation* is perceived as positive by extraversion, agreeableness, and conscientiousness and does not negatively impact other personality types. *Simulation* is also one of the highly-rated strategies. Therefore, to appeal to a broad audience, persuasive games and gamified systems **should be designed to show the cause-and-effect linkage and projected outcome of an individual's health behavior**. Game elements such as *status*, *appointments*, *leaderboards*, *achievements*, *epic meaning*, *behavior momentum*, *blissful productivity*, and *urgent optimism* that structure play and give players an idea of how their behavior will impact their lives could be used to create a simulated experience of the real-world behavior within the context of play.

Our results also show that *goal setting* and *suggestion* is a significant motivator of behavior for extraverted and conscientious individuals and does not negatively impact other personality types. *Goal setting* and *suggestion* are also one of the highly preferred strategies overall. Therefore, to appeal to a broad user population, persuasive games and gamified systems **should be designed to allow users to set their own goals and offer suggestions on both how to set effective goals and how to reach the goals.** Game elements such as *quest*, *appointments*, *status*, *level*, *reward schedule*, and *countdown* that structure play around target task and time-required-to-complete-them could be used to set clear goals about the real-world behavior and offer suggestions on how to achieve them.

From the qualitative comments, participants expressed a common concern about the three strategies *personalization*, *simulation*, and *goal setting* and *suggestion.* They are perceived as "not fun", "boring", "not engaging" and, "not incentivizing" enough. Therefore, **we recommend that designers should apply *personalization, simulation,* and *goal setting and suggestion* strategies together with fun and incentive-oriented strategies such as *rewards* (badges, points, bonuses), *competition,* and *comparisons* (ranking, status, leaderboard, envy) to reinforce them.**

Designing for Users with a Specific Personality Type
Although designing for the broadest possible audience is a common practice, tailoring persuasive experiences to individual users or user groups has been advocated

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[2] For detailed definitions of the game elements and the mapping of the persuasive strategies to some common game mechanics see Orji et al. [53].

[35,49,50]. Our results reveal opportunities where personalizing game experience by tailoring the strategies based on users' personality is highly desirable.

Our results show that *personalization* (system tailoring as opposed to user customization) is the only strategy that is perceived as positive by people who are very open to experience. However, people who are less open to experience are more likely to prefer customization. These findings mean that people who are more open to experience are more likely to be motivated using *system-controlled* tailoring (personalization) while people who are less open are more likely to be motivated by *user-controlled* tailoring (customization). A possible explanation is that people who feel threatened by losing control and those who are conscious about privacy tend to be more influenced by the affordance of agency in customization and tend to explore all customizable features provided by a system [53]. Individuals who are less open to experience fall into this category. On the other hand, people who are more persuaded by system relevance (and care less about control) of the resulting content tend to use only the default features [60] and hence prefer personalization — more openness to experience people belong to this category. Therefore, **we suggest that when designing to specifically appeal to people who are more open to experience, designers should personalize the system using system-controlled tailoring**. However, **when designing to specifically appeal to people who are less open to experience, designers should employ user-controlled tailoring.**

For people high in conscientiousness, our results show that they have strong preference for *goal setting and suggestion*, *simulation*, *personalization*, *and self-monitoring* and *feedback* and therefore are more likely to be motivated by systems employing these strategies. Therefore, when designing **to specifically appeal to people high in conscientiousness, designers should employ *goal setting and suggestion, simulation, personalization, and self-monitoring* and *feedback.*** This may demotivate behavior for people low in conscientiousness. **Therefore, designers should avoid using these strategies for this group.**

Surprisingly, our findings show that neurotic individuals are less likely to be motivated to adopt healthy behaviors using any of the strategies studied. One possible explanation is that most commonly employed persuasive strategies are not suitable for neuroticism personality traits. Therefore, **persuasive games and gamified systems should explore neuroticism-oriented persuasive strategies.** Another possible reason is that persuasion may not work for everyone, there is a limit to what and who can be persuaded to adopt healthy behavior using the persuasive strategies. Therefore, **for neuroticisms, persuasion may not be an effective approach for motivating behavior change.**

Finally, our findings reveal that extraversion, agreeableness, and openness are the three personality traits that predict most of the variability in the effectiveness of

persuasive strategies. Extraversion and agreeableness are significantly and positively associated with most strategies while openness is negatively associated with most strategies. Therefore, **to achieve personality-driven tailoring, it is necessary to differentiate participants based on these traits (at least)**.

There are many ways in which persuasive games and gamified systems could be tailored based on our results, we have highlighted a few here as examples. Table 4 details the relations between the strategies and personality traits which could guide design choices for tailoring persuasive games and gamified systems.

Other Design Implications

Socially-oriented persuasive strategies such as competition, comparison, and cooperation are among the most frequently employed strategies both in persuasive and gamified systems and other online support systems because of their ability to leverage the power of social influence to motivate behavior change. Our findings reveal that these socially-oriented strategies are likely to demotivate people who are introverted, open to experience, and less agreeable. Our qualitative results show that this group of people perceive these strategies as *invasive*, *less privacy preserving*, and *has a high potential of harming friendship*. A participant noted that she would compete if it did not require disclosing her personal data. Therefore, we suggest that **to target these group of people, designers should include mechanisms that allow users to hide their identity or use nicknames. Designers should also make it possible for individuals to work with strangers that cannot possibly identify them.**

The qualitative comments show that socially-oriented strategies (competition, comparison, and cooperation) have the potential of being counterproductive by demotivating behaviors if not strategically implemented. As highlighted by the comment *"This type of game could go **both ways**...if I drink less than my friends, it may make me drink more. So it basically comes down to what type of friends one is comparing with and if they promote drinking or not"* [P394]. Therefore, **care should be taken when employing these strategies to reduce the possibility of downward comparison**. Designers can pre-screen and redistribute users across groups to ensure effective social circle for comparison. Designers can also include mechanism that allow for both within and between-group comparisons.

LIMITATIONS

First, our study presents the self-reported persuasiveness of various strategies implemented in storyboards, but the actual persuasiveness of the strategies may differ when implemented in a specific game. Therefore, we plan to examine the persuasiveness of the recommended strategies deployed in an actual gamified persuasive system. Secondly, while our work has benefited from the large-scale study of persuasiveness of the strategies with respect to unhealthy alcohol behavior change and we can claim applicability in other health behavior domains (due to the high level nature of the storyboard depicting the strategies), our results may not generalize to other behavior domains and therefore should be applied with caution in these domains.

CONCLUSION AND FUTURE WORK

The current study investigates the relations between personality and persuasive strategies as highlighted by the Persuasive Systems Design Framework for the first time in the literature. Specifically, the paper contributes to the HCI community by advancing understanding on how an individual's personality traits determine their preference and responsiveness to various persuasive strategies that are widely used in persuasive games and gamified systems. As a secondary objective, we validated the persuasiveness of the strategies and showed their comparative persuasiveness with respect to their ability to motivate risky health behavior change. Our results show that people's personality traits play significant roles in their responsiveness and preference for various persuasive strategies. Through the study, we exposed the limitations of the untailored approach and presented design opportunities for designing persuasive games and gamified systems that appeal both to a broad audience and can be tailored to a particular personality trait. Our findings indicate that *extraversion*, *agreeableness*, and *openness* are the three personality traits that predict most of the variance in the effectiveness of the persuasive strategies. In general, *personalization*, *simulation*, *goal setting* and *suggestion*, *self-monitoring and feedback*, and *social comparison* are the most persuasive of all the strategies while *punishment* and *customization* are the least persuasive. Our results could guide designers in making informed choices on the strategies to employ and those to avoid when designing persuasive games and gamified systems tailored to various users' personalities.

Although this study showed many interesting and significant findings, it also opens up many areas for further examination. Future research should compare the effectiveness of the strategies in actual persuasive games. Again, our results should be validated in other health behavior domains (e.g., discouraging drug use, risky sexual behavior, and smoking) to investigate possible changes in the persuasiveness of the strategies. Our results highlight differences in relations between the personality traits and the 10 persuasive strategies—this suggests a need for a persuasion profile comprised of a comprehensive list of strategies to motivate different personalities.

REFERENCES

1. Atif Alamri, Mohammad Mehedi Hassan, M. Anwar Hossain, Muhammad Al-Qurishi, Yousuf Aldukhayyil, and M Shamim Hossain. 2014. Evaluating the impact of a cloud-based serious game on obese people. *Computers in Human Behavior* 30: 468–475. http://doi.org/10.1016/j.chb.2013.06.021

2. Sonia M. Arteaga, Víctor M. González, Sri Kurniawan, and Raquel a. Benavides. 2012. Mobile games and design requirements to increase teenagers' physical activity. *Pervasive and Mobile Computing* 8, 6: 900–908. http://doi.org/10.1016/j.pmcj.2012.08.002

3. Sonia M. Arteaga, Mo Kudeki, and Adrienne Woodworth. 2009. Combating obesity trends in teenagers through persuasive mobile technology. *ACM SIGACCESS Accessibility and Computing*, 94: 17–25. http://doi.org/10.1145/1595061.1595064

4. Magnus Bang, Carin Torstensson, and Cecilia Katzeff. 2006. The PowerHhouse: A Persuasive Computer Game Designed to Raise Awareness of Domestic Energy Consumption. *Persuasive Technology*: 123–132. http://doi.org/http://dx.doi.org/10.1007/11755494_33.

5. Marek Bell, Matthew Chalmers, Louise Barkhuus, et al. 2006. Interweaving mobile games with everyday life. *Proceedings of the {SIGCHI} conference on Human Factors in computing systems*, ACM, 417–426. http://doi.org/10.1145/1124772.1124835

6. Shlomo Berkovsky, Mac Coombe, Jill Freyne, Dipak Bhandari, and Nilufar Baghaei. 2010. Physical activity motivating games: virtual rewards for real activity. *Proceedings of the International Conference on Human Factors in Computing Systems*, ACM, 243–252. http://doi.org/10.1145/1753326.1753362

7. Max Birk and Regan L. Mandryk. 2013. Control your game-self. *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems - CHI '13*, ACM Press, 685. http://doi.org/10.1145/2470654.2470752

8. M Buhrmester, T Kwang, and Gosling S. D. 2011. Amazon's Mechanical Turk A New Source of Inexpensive, Yet High-Quality, Data? *Perspectives on Psychological Science* 6, 1: 3–5. http://doi.org/doi: 10.1177/1745691610393980

9. Marc Busch, E. Mattheiss, M. Reisinger, R. Orji, P. Fröhlich, and M. Tscheligi. 2016. *More than sex: The role of femininity and masculinity in the design of personalized persuasive games*. http://doi.org/10.1007/978-3-319-31510-2_19

10. Marc Busch, Elke Mattheiss, Wolfgang Hochleitner, et al. 2016. Using Player Type Models for Personalized Game Design - An Empirical Investigation. *International Journal on Interaction Design & Architecture(s)* Accepted f.

11. Wynne W. Chin. 1998. The Partial Least Squares Approach to Structural Equation Modeling. *Modern Methods for Business Research* 292, 2: 298–336.

12. Nathalie Colineau and Cécile Paris. 2011. Can beneficial habits be induced through reflection. *Workshop on User Models for Motivational Systems, held in conjunction with the User Modeling, Adaptation and Personalization Conference*. Retrieved from http://www.ict.csiro.au/staff/nathalie.colineau/publications/Colineau-Paris_WorkshopUM4Motivation.pdf

13. Sunny Consolvo, David W McDonald, and James A Landay. 2009. Theory-driven design strategies for technologies that support behavior change in everyday life. *Proceedings of the international conference on Human factors in computing systems*, ACM, 405–414. http://doi.org/10.1145/1518701.1518766

14. Aubrey C. Daniels. 2000. *Bringing Out the Best in People: How to Apply the Astonishing Power of Positive Reinforcement*. McGraw-Hill.

15. Filip Drozd, Tuomas Lehto, and Harri Oinas-Kukkonen. 2012. Exploring perceived persuasiveness of a behavior change support system: A structural model. *Lecture Notes in Computer Science (including subseries Lecture Notes in Artificial Intelligence and Lecture Notes in Bioinformatics)*, 157–168. http://doi.org/10.1007/978-3-642-31037-9_14

16. Brian J. Fogg. 2003. *Persuasive Technology: Using Computers to Change What We Think and Do*. Morgan Kaufmann. http://doi.org/10.1145/764008.763957

17. Yuichi Fujiki, Konstantinos Kazakos, Colin Puri, Pradeep Buddharaju, Ioannis Pavlidis, and James Levine. 2008. {NEAT-o-Games:} blending physical activity and fun in the daily routine. *Computers in Entertainment* 6, 2: 1–22. http://doi.org/10.1145/1371216.1371224

18. Kathrin M Gerling, Regan L Mandryk, Max Birk, Matthew Miller, and Rita Orji. The Effects of Embodied Persuasive Games on Player Attitudes Toward People Using Wheelchairs. http://doi.org/10.1145/2556288.2556962

19. Lewis. R Goldberg. 1993. The structure of phenotypic personality traits. *American Psychologist* 48, 1: 26–34. http://doi.org/10.1037/0003-066X.48.1.26

20. Andrea Grimes, Vasudhara Kantroo, and Rebecca E Grinter. 2010. Let's play!: mobile health games for adults. *Proceedings of the 12th ACM international conference on Ubiquitous computing*: 241–250. http://doi.org/10.1145/1864349.1864370

21. Andrea Grimes, Desney Tan, and Dan Morris. 2009. Toward technologies that support family reflections on health. *Proceedings of the {ACM} 2009 international conference on Supporting group work*, ACM, 311–320. http://doi.org/10.1145/1531674.1531721

22. Joe F. Hair, Christian M. Ringle, and Marko Sarstedt. 2011. PLS-SEM: Indeed a Silver Bullet. *Journal of Marketing Theory and Practice* 19, 2: 139–152. http://doi.org/10.2753/MTP1069-6679190202

23. Sajanee Halko and Julie A Kientz. 2010. Personality and persuasive technology: An exploratory study on health-promoting mobile applications. *Persuasive Technology*, Springer, 150–161. http://doi.org/10.1007/978-3-642-13226-1_16

24. Juho Hamari, Jonna Koivisto, and Tuomas Pakkanen. 2014. Do Persuasive Technologies persuade ? - A review of empirical studies. *Proceedings of Persuasive'14, LNCS 8462*, Springer International Publishing Switzerland, 118–136.

25. Juho Hamari, Jonna Koivisto, and Harri Sarsa. 2014. Does gamification work? - A literature review of empirical studies on gamification. *Proceedings of the Annual Hawaii International Conference on System Sciences*, JANUARY: 3025–3034. http://doi.org/10.1109/HICSS.2014.377

26. Jacob B Hirsh, Sonia K Kang, and Galen V Bodenhausen.

2012. Personalized persuasion: tailoring persuasive appeals to recipients' personality traits. *Psychological science* 23, 6: 578–81. http://doi.org/10.1177/0956797611436349

27. Marc Busch, Mattheiss Elke, Rita Orji, Marczewski, Andrzej, Wolfgang Hochleitner, Michael Lankes, Lennart E. Nacke, Tscheligi, Manfred. 2015. Personalization in serious and persuasive games and gamified interactions. *CHI PLAY 2015 - Proceedings of the 2015 Annual Symposium on Computer-Human Interaction in Play*: 811–816. http://doi.org/10.1145/2793107.2810260

28. Astrid Jander, Rik Crutzen, Liesbeth Mercken, Math Candel, and Hein de Vries. 2016. Effects of a Web-Based Computer-Tailored Game to Reduce Binge Drinking Among Dutch Adolescents: A Cluster Randomized Controlled Trial. *Journal of medical Internet research* 18, 2: e29. http://doi.org/10.2196/jmir.4708

29. Astrid Jander, Rik Crutzen, Liesbeth Mercken, and Hein De Vries. 2014. A Web-based computer-tailored game to reduce binge drinking among 16 to 18 year old Dutch adolescents: development and study protocol. *BMC Public Health* 14: 1054. http://doi.org/10.1186/1471-2458-14-1054

30. John B. Jemmott, Loretta Sweet Jemmott, and Geoffrey T. Fong. 1992. Reductions in HIV risk-associated sexual behaviors among black male adolescents: effects of an AIDS prevention intervention. *American Journal of Public Health* 82, 3: 372–377. http://doi.org/10.2105/AJPH.82.3.372

31. Shih-Ping Jeng and Ching-I Teng. 2008. Personality and motivations for playing online games. *Social Behavior and Personality: an international journal* 36, 8: 1053–1060. http://doi.org/10.2224/sbp.2008.36.8.1053

32. Yuan Jia, Bin Xu, Yamini Karanam, and Stephen Voida. 2016. Personality,targeted/Gamification: A Survey Study on Personality Traits and Motivational Affordances. *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems*. http://doi.org/10.1145/2858036.2858515

33. Daniel Johnson and John Gardner. 2010. Personality, Motivation and Video Games. *Proceedings of the 22nd Conference of the Computer-Human Interaction Special Interest Group of Australia on Computer-Human Interaction - OZCHI '10*, 276. http://doi.org/10.1145/1952222.1952281

34. Henry F. Kaiser. 1970. A second generation little jiffy. *Psychometrika* 35, 4: 401–415. http://doi.org/10.1007/BF02291817

35. Maurits Kaptein, Boris De Ruyter, Panos Markopoulos, and Emile Aarts. 2012. Adaptive Persuasive Systems. *ACM Transactions on Interactive Intelligent Systems* 2, 2: 1–25. http://doi.org/10.1145/2209310.2209313

36. Rilla Khaled, Ronald Fischer, James Noble, and Robert Biddle. 2008. A qualitative study of culture and persuasion in a smoking cessation game. *Proceedings of the Third International Conference on Persuasive Technology for Human Well-Being*, Springer Berlin Heidelberg, 224–236. http://doi.org/10.1007/978-3-540-68504-3-20

37. Yvonne Klisch, Leslie M Miller, Margaret E Beier, and Shu Wang. 2012. Teaching the biological consequences of alcohol abuse through an online game: Impacts among secondary students. *CBE Life Sciences Education* 11, 1: 94–102. http://doi.org/10.1187/cbe.11-04-0040

38. Yvonne Klisch, Leslie M Miller, Shu Wang, and Joel Epstein.

2012. The Impact of a Science Education Game on Students' Learning and Perception of Inhalants as Body Pollutants. *Journal of Science Education and Technology* 21, 2: 295–303. http://doi.org/10.1007/s10956-011-9319-y

39. Emil Kupek. 2006. Beyond logistic regression: structural equations modelling for binary variables and its application to investigating unobserved confounders. *BMC medical research methodology* 6, 1: 13. http://doi.org/10.1186/1471-2288-6-13

40. Tuomas Lehto and Harri Oinas-Kukkonen. 2011. Persuasive features in web-based alcohol and smoking interventions: a systematic review of the literature. *Journal of medical Internet research* 13, 3: e46. http://doi.org/10.2196/jmir.1559

41. Corrie Lelie. 2005. The value of storyboards in the product design process. *Personal and Ubiquitous Computing* 10, 2–3: 159–162. http://doi.org/10.1007/s00779-005-0026-7

42. Edwin Locke and Gary Latham. 1994. Goal-setting theory.

43. Salvatore R. Maddi. 1989. *Personality theories: A comparative analysis, 5th ed.* Dorsey Press.

44. Winter Mason and Siddharth Suri. 2012. Conducting behavioral research on Amazon's Mechanical Turk. *Behavior research methods* 44, 1: 1–23. http://doi.org/10.3758/s13428-011-0124-6

45. Oded Nov and Ofer Arazy. 2013. Personality-targeted design: theory, experimental procedure, and preliminary results. *Proceedings of the 2013 conference on Computer …*, 977–984. http://doi.org/10.1145/2441776.2441887

46. Harri Oinas-kukkonen and Marja Harjumaa. 2008. A Systematic Framework for Designing and Evaluating Persuasive Systems. *PERSUASIVE*, Springer, 1–5. http://doi.org/10.1007/978-3-540-68504-3

47. Harri Oinas-kukkonen and Marja Harjumaa. 2009. Persuasive Systems Design : Key Issues , Process Model , and System Features Persuasive Systems Design : Key Issues , Process Model , and System Features. *Communications of the Association for Information Systems* 24, 1: 28.

48. Rita Orji, Regan L. Mandryk, and Julita Vassileva. 2015. *Gender, age, and responsiveness to cialdini's persuasion strategies.* http://doi.org/10.1007/978-3-319-20306-5_14

49. Rita Orji. 2014. Design for Behaviour Change: A Model-driven Approach for Tailoring Persuasive Technologies. PhD Thesis: 1–257. Retrieved from http://hdl.handle.net/10388/ETD-2014-06-1555

50. Rita Orji, Regan L. Mandryk, Julita Vassileva, and Kathrin M. Gerling. 2013. Tailoring persuasive health games to gamer type. *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems - CHI '13*, ACM Press, 2467–2476. http://doi.org/10.1145/2470654.2481341

51. Rita Orji and Karyn Moffatt. 2016. Persuasive technology for health and wellness: State-of-the-art and emerging trends. *Health Informatics Journal* 1: 7–9. http://doi.org/10.1177/1460458216650979

52. Rita Orji, Julita Vassileva, and Regan L. Mandryk. 2012. LunchTime: a slow-casual game for long-term dietary behavior change. *Personal and Ubiquitous Computing* 17, 6: 1211–1221. http://doi.org/10.1007/s00779-012-0590-6

53. Rita Orji, Julita Vassileva, and Regan L. Mandryk. 2014. Modeling the efficacy of persuasive strategies for different

gamer types in serious games for health. *User Modeling and User-Adapted Interaction* 24, 5: 453–498. http://doi.org/10.1007/s11257-014-9149-8

54. Jowon Park, Yosep Song, and Ching-I Teng. 2011. Exploring the links between personality traits and motivations to play online games. *Cyberpsychology, Behavior, and Social Networking* 14, 12: 747–51. http://doi.org/10.1089/cyber.2010.0502

55. Jr. Paul T. Costa and Robert R. McCrae. 1992. *NEO Personality Inventory–Revised (NEO-PI-R) and NEO Five-Factor Inventory (NEO-FFI) Professional Manua*. Psychological Assessment Resources, Odessa, FL.

56. Nicole Peever, Daniel Johnson, and John Gardner. 2012. Personality & video game genre preferences. *Proceedings of The 8th Australasian Conference on Interactive Entertainment Playing the System - IE '12*: 1–3. http://doi.org/10.1145/2336727.2336747

57. Beatrice Rammstedt and Oliver P. John. 2007. Measuring personality in one minute or less: A 10-item short version of the Big Five Inventory in English and German. *Journal of Research in Personality* 41, 1: 203–212. http://doi.org/10.1016/j.jrp.2006.02.001

58. Christian M. Ringle, S Wende, and J Becker. smartpls.de - next generation path modeling. Retrieved August 29, 2012 from http://www.smartpls.de/forum/contact.php

59. Burrhus F. Skinner. 1953. *Science And Human Behavior*. Simon and Schuster. http://doi.org/10.1037/h0052427

60 Shyam S. Sundar and Sampada S. Marathe. 2010. Personalization versus Customization: The Importance of Agency, Privacy, and Power Usage. *Human Communication Research* 36, 3: 298–322. http://doi.org/10.1111/j.1468-2958.2010.01377.x

61. R Thomas, J Cahill, and L Santilli. 1997. Using an Interactive Computer Game to Increase Skill and Self-Efficacy Regarding Safer Sex Negotiation: Field Test Results. *Health Education and Behavior* 24, 1: 71–86. http://doi.org/10.1177/109019819702400108

62. Gustavo F Tondello, Rina R Wehbe, Lisa Diamond, Marc Busch, Andrzej Marczewski, and Lennart E Nacke. The Gamification User Types Hexad Scale. http://doi.org/10.1145/2967934.2968082

63. Tammy Toscos, Anne Faber, Shunying An, and Mona Praful Gandhi. 2006. Chick clique: persuasive technology to motivate teenage girls to exercise. *{CHI} '06 extended abstracts on Human factors in computing systems*, ACM, 1873–1878. http://doi.org/10.1145/1125451.1125805

64. Khai N Truong, Gillian R Hayes, and Gregory D Abowd. 2006. Storyboarding: An Empirical Determination of Best Practices and Effective Guidelines. *DIS '06 Proceedings of the 6th conference on Designing Interactive systems, ACM New York, NY, USA*, 12–21. http://doi.org/10.1145/1142405.1142410

65. Veronica Lorena Zammitto. 2010. Gamers' Personality and their Gaming Preferences. *School of Interactive Arts and Technology M.Sc Thesi*. Retrieved April 10, 2014 from http://summit.sfu.ca/item/11349