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Modeling the efficacy of persuasive strategies for different gamer types in serious games for health

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Abstract Persuasive games for health are designed to alter human behavior or attitude using various Persuasive Technology (PT) strategies. Recent years have witnessed an increasing number of such games, which treat players as a monolithic group by adopting a one-size-fits-all design approach. Studies of gameplay motivation have shown that this is a bad approach because a motivational approach that works for one individual may actually demotivate behavior in others. In an attempt to resolve this weakness, we conducted a large-scale study on 1,108 gamers to examine the persuasiveness of ten PT strategies that are commonly employed in persuasive game design, and the receptiveness of seven gamer personalities (gamer types identified by BrianHex) to the ten PT strategies. We developed models showing the receptiveness of the gamer types to the PT strategies and created persuasive profiles, which are lists of strategies that can be employed to motivate behavior for each gamer type. We then explored the differences between the models and, based on the results, proposed two approaches for data-driven persuasive game design. The first is the one-size-fits-all approach that will motivate a majority of gamers, while not demotivating any player. The second is the personalized approach that will best persuade a particular type of gamer. We also compiled a list of the best and the worst strategies for each gamer type. Finally, to bridge the gap between game design and PT researchers, we map common game mechanics to the persuasive system design strategies.

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1 Introduction

The increase in lifestyle-related health problems (e.g., obesity, sedentariness) has motivated a shift from a treatment-and-prescription focused healthcare system to a prevention-focused system that is patient-centric and emphasizes promotion of healthy behavior. Adoption of healthy behavior can prevent or at least reduce the risk of many diseases including obesity, heart disease, and type 2 diabetes (Wansink 2006). It is, therefore, not surprising that interventions aimed at modifying behavior have been identified as a major solution to these health conditions (Lau et al. 2007). As a result, research efforts have been focused on how to use technology to motivate healthy behavior.

Persuasive Technology (PT), aims to bring about desirable change by shaping and reinforcing behavior, attitude, and thoughts about an issue, action, or object (Berkovsky et al. 2012; Fogg 2003) using various strategies. PT has proven effective at stimulating behavior change in various domains including smoking cessation (Dijkstra 2006; Khaled 2008), lowering energy consumption (Bang et al. 2006), motivating physical activity (Berkovsky et al. 2010), and healthy eating (Orji et al. 2012). Among all these domains, applications for promoting healthy eating behavior have attracted special attention (Grimes et al. 2010; Orji et al. 2012; Thompson et al. 2010), yet there remains a need for research into the various approaches to designing applications for motivating healthy eating behavior (Government of Canada, Health Canada 2003). Unhealthy eating behavior is a major factor contributing to the onset of several diseases and health conditions; for example, the rise in obesity is often linked to unhealthy eating (Maddock Maddock; Orji et al. 2012). Therefore, in this paper, we use healthy eating as a case study for investigating the persuasiveness of various PT strategies to motivate healthy behavior.

PT designers use several approaches to deliver their interventions to effect change in the end user—the preferred approaches being those that are natural or common among the target users (e.g., playing computer games is a very common activity among young people). As a result, delivering PT in the form of a game has become a common practice. We refer to these types of games as *persuasive games*. Persuasive games are interventions with the primary purpose of changing a user's behavior or attitude (Fogg 2003) using various PT strategies. Persuasive games have attracted attention as a novel approach for promoting healthy behavior change because of their motivational pull (Rigby and Ryan 2011). In the last decade, several persuasive games targeted at modifying users' behaviors have been developed (Bang et al. 2006; Berkovsky et al. 2010; Khaled et al. 2007; Orji et al. 2012); however, these games generally take a one-size-fits-all approach, rather than tailoring their contents and strategies to individual users or user groups. Several researchers have pointed to the limitations and risks of the *one-size-fits-all* approach to persuasive intervention design, especially when aimed at motivating health behavior. For example, Henseler et al. (2009), in their comparative study of the effect of tailored and contra-tailored strategies, discovered that the contra-tailored strategies (inappropriate strategies) led to strong adverse reactions that tended to increase the adoption of the unhealthy behavior that the intervention had intended to decrease. Thus, they concluded that the most important use of tailoring is to prevent the use of badly chosen influence strategies that can be counterproductive or backfire (Kaptein et al. 2012). Similarly, in our investigation of the influence of theoretical determinants on gamer types, we discovered that manipulating certain determinants of healthy behaviour (e.g., perceived severity, cue to action) in persuasive game design can demotivate intended eating behaviour in some people depending on their dominant gamer type (Orji et al. 2013).

The realization that the one-size-fits-all approach may not be sufficient to motivate healthy behavioral change has led to a growing interest in finding ways of tailoring interventions to various users and user groups. For example, previous work has shown that a user's personality is an important determinant of motivation and persuadability (Hu and Pu 2010; Kaptein et al. 2010). Further work showed a relationship between the user's personality and the success of different influence strategies (Halko 2010). Although a few persuasive games have been designed with a specific user or cultural group in mind (e.g., Grimes et al. 2010; Khaled 2008), the influence of various gamer personalities (gamer types)—as identified by various game design researchers (e.g., BrainHex Bateman and Nacke 2010)—on persuasive game and choice of persuasive strategy has largely been ignored. However, decades of research on gameplay motivation has shown that treating gamers as a monolithic group is a bad design approach (Brown 2009; Buhrmester 2011)—as what works for one individual may actually demotivate behavior change in another (Orji et al. 2013). Therefore, members of one gamer type may respond differently to various strategies and applications, and persuasive gaming interventions will be more effective when they are strategically appropriate for the gamer type under consideration.

In this paper, we propose a design approach for tailoring PT interventions to various gamer personalities. Our design guidelines are based on a quantitative study of 1,108 gamers, where we studied the perceived persuasiveness of ten commonly used PT strategies (*customization, simulation, self-monitoring and feedback, suggestion, personalization, simulation, praise, reward, comparison, competition,* and *cooperation*) identified by Oinas-Kukkonen and Harjumaa (2008) and Fogg (2003) on gamers of seven types (*achiever, conqueror, daredevil, mastermind, seeker, socializer, and survivor*) identified by the BrainHex model (Bateman and Nacke 2010). We employed Exploratory Factor Analysis (EFA) and Partial Least Square (PLS) Structural Equation Modeling (SEM) to develop models showing the persuasiveness of the ten strategies for various gamer types. Our models reveal several differences and some similarities in the perception of various PT strategies by the gamer types. Based on the results of our models, we highlighted the best and the worst strategies for designing for each gamer type. We also present the best and worst overall PT strategies. Finally, we propose two approaches for designing persuasive games: a '*one-size-fits-all*' approach that will appeal to the majority of gamers, while not demotivating any types, and a *personalized* approach that tailors persuasive games for health behavior to gamer personality. To make our findings more actionable, we suggest mappings of PT strategies to common game mechanics that can be employed in persuasive game design.

Our three main contributions are as follows: First, we conducted a cross validation of the persuasiveness of ten commonly employed strategies and developed models showing the receptiveness of the seven gamer types to the strategies and persuasive profiles (comprising a list of suitable PT strategies) for each gamer type identified by BrainHex. Second, we examined both the inter-group differences (differences between the gamer types with respect to their receptiveness to the strategies) and intra-group differences (the differences in the persuasiveness of each strategy relative to other strategies on the same gamer type) and discussed these differences from several perspectives: the strategies (highlighting the best overall strategies and the least efficacious strategies), health behavior, gamer types, and persuasive game design. Finally, to bridge the gap between PT and game designers, we proposed a mapping of PT strategies to appropriate game design mechanics.

To the best of our knowledge, this study is the first to link research on the psychology of player typologies (as identified by BrainHex) with persuasive strategies to find patterns in gamers' motivation that can inform the choice of PT strategies and game mechanics for designing games that will motivate behavior change. Our paper argues that having a persuasive profile of various PT strategies that motivate different gamer types provides a crucial methodological bridge between game and PT researchers and also between personalization and PT researchers. We propose a data-driven approach for designing personalized persuasive game that will benefit from best practices in both game design and persuasive technology.

2 Related work

In this section, we present a brief review of PT strategies. This is followed by an overview of game-based interventions, with a focus on interventions for health and PT strategies employed. We conclude by presenting a brief overview of gamer types with an emphasis on the BrainHex gamer type model and tailoring PT to users and user groups.

2.1 Persuasive strategies

Over 20 years of research, a number of PT strategies have been developed. For instance, Cialdini (2004) developed six persuasive principles, Fogg (2003) developed seven persuasive tools, and Oinas-Kukkonen and Harjumaa (2008) built on Fogg's strategies to develop 28 persuasive system design principles. These strategies are often applied in combinations when incorporated in actual software (Harjumaa 2009). Therefore, it is common practice for researchers in persuasion to select a combination of strategies from various authors to inform their design. The choice and the suitability of a strategy for a particular behavior and user group are often based on a designer's own intuition, making it difficult to tailor strategies to users or user groups.

Considering that the large number of PT strategies in existence today cannot be exhausted in a study, in this paper we adopt 10 strategies (from Fogg and Oinas-Kukkonen). These ten strategies were chosen after a review of literature on persuasive games and the strategies they employ. Recent reviews also identified these strategies among the commonly used PT strategies in persuasive systems design (Lehto 2010; Wiafe and Nakata 2012). *Customization* is a strategy that provides the user an opportunity to adapt a system's contents and functionality to their needs or choices. *Simulation* provides the means for a user to observe the cause-and-effect linkage of their behavior. It is one of the rarely employed strategies in health game design. *Self-monitoring* (also called *Feedback*) allows people to track their own behaviors, providing information on both past and current states. It is one of the most common strategies for healthy eating and physical activity motivating applications (Brown et al. 2006; Tsai et al. 2007). The *Suggestion* strategy suggests certain tasks (for achieving favorable behaviour outcomes) to users during system use. *Praise* applauds the user for performing the target behavior via words, images, symbols, or sounds as a way to give positive feedback to the user (for example in Bang et al. 2006; Toscos et al. 2006). *Reward* offers virtual rewards to users for performing the target behavior. It is one of the commonly employed strategies (Bell et al. 2006; Grimes et al. 2010; Orji et al. 2012). *Competition* allows the user to compete with others. *Comparison* provides a means for the user to view and compare his/her performance with the performance of other user(s). Competition, and Comparison are included among the commonly used strategies. *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 services to its users, tailoring content and functionality to a particular user's need based on a user's characteristics. For a detailed discussion of the strategies see Oinas-Kukkonen and Harjumaa (2008).

It is important to note that these ten strategies are not more important than the rest and may not be representative of all strategies. However, from the literature, they are the most commonly used PT strategies (Lehto 2010; Wiafe and Nakata 2012) in persuasive health games and hence, we chose to adopt them in this study.

2.2 Game-based interventions

Persuasive technology aims to bring about desirable change in attitude and/or behavior without using coercion or deception (Fogg 2003); persuasive games are PTs that use game-based approaches to their intervention design. Studies have shown that games can be an effective approach to trigger behavior change in an intended manner (Khaled et al. 2007; Orji et al. 2012). Various terms and definitions have been given to games designed for purposes other than entertainment. For instance, the term *serious games* for health has been used to define games that are designed to entertain, educate, and train players, while attempting to modify some aspect of the player's health behavior (Stokes 2005). Bogost used the term *persuasive game* to describe video games that apply procedural rhetoric effectively (Bogost 2007). However, for the purpose of this paper, we define persuasive games as games that are designed with the primary purpose of changing a user's behavior or attitude using various persuasive techniques (Fogg 2003).

Persuasive games have been applied in many domains including education, sustainability, and health. In the health domain, persuasive games can broadly be categorized into two main areas: *persuasive games for health promotion and prevention* and *persuasive games for disease management* (Orji et al. 2013).

2.2.1 Game-based interventions for health promotion and prevention

Preventive health behaviors include behaviors that are undertaken by individuals for the purpose of preventing illness, detecting early illness symptoms, and maintaining general wellbeing (Shegog 2010). Examples include smoking cessation (Dijkstra 2006; Khaled 2008), being physically active (Berkovsky et al. 2010), and healthy eating (Orji et al. 2012). Several persuasive games have been developed for health promotion and prevention. For example, *National Mindless Eating Challenge* (NMEC) is a mobile phone-based health game aimed at promoting healthy eating behavior (Kaipainen et al. 2012). NMEC employs the *reward, comparison, customization, suggestion,* and *personalization* strategies. NMEC players are tasked with caring for a virtual pet or plant and this requires them to follow a variety of healthy eating recommendations. At the beginning of the game, the player selects an initial eating goal and sub-goal and based on their chosen goals, players are assigned tasks that are relevant to their eating goals—*personalization.* The game also allows players the flexibility to enable and disable various game features—*customization.* At the end of each month, players are evaluated and given new suggestions on how to reach their goals in the subsequent month—*suggestion.* Players also receive *reward*s and compare their performance with the performance of others—*comparison*. During the evaluation of NMEC, the researchers recorded high attrition rates and identified personally unsuitable tips and strategies as the major barrier that prevented people from making changes.

Similarly, *LunchTime* is a slow-casual game for motivating healthy eating (Orji et al. 2012). *LunchTime* employs the *reward, competition,* and *comparison* strategies. Players play the role of a restaurant visitor, and the goal is to choose the healthiest option from a list of food choices. Players are awarded points—*reward*—and each player is allowed to view and compare their points with that of other players—*competition* and *comparison*. *Squire's Quest!* is a 10-session computer game aimed at increasing children's consumption of fruit, juice, and vegetables (FJVs) and thus prevent or at least reduce the incidence of diet-related disease (Cullen et al. 2005). *Squire's Quest!* Employs the *personalization, simulation, reward, competition* and *comparison* strategies. In the game, kids play as a squire who faces the challenge of helping the king and queen defeat invaders who are attempting to destroy their kingdom by destroying the fruit and vegetable crops. The challenges for the squire are to master the skills necessary to prepare fruit, juice, and vegetable (FJV) recipes to provide energy for the king and his court, with goals related to eating more nutritious FJVs. The game involves tailoring of decision making to reported FJV preferences of a player—*personalization*. The game also reinforces healthy eating behavior by awarding points based on goal attainment—*reward*. The number of earned points determines the level of their knighthood—*competition* and *comparison*. The game also provides a simulation of the physical environment—*simulation*. Finally, *Right-Way Café* is a role playing game that employs *customization, competition, simulation, personalization,* and *suggestion* to promote healthy eating and physical activity

(Peng 2009). At the beginning of the game, the players create a representative avatar using their own personal information, such as name, weight, height, age, gender, physical activity, and body frame—*customization*. Using the specified attributes of the avatar, the game provides *personalized* healthy eating and *suggestions* with regard to optimal weight and daily calorie consumption. A player is tasked with the role of managing the avatar's daily calorie consumption and physical activity to enable it to reach optimal weight. The player who best managed the avatar's daily diet in a healthy way wins the game—*competition*. At the end of each week the game simulates the weight change based on the foods the player chooses—*simulation.*

The evaluated game-based interventions reported varying degrees of success at achieving health objectives and high attrition rates (Kaipainen et al. 2012). The mixed findings and high attrition rates may be due to possible individual differences in the effect of various strategies adopted in the game design (Kaptein et al. 2012), because most of the games employed the one-size-fits-all approach in their design. Almost all reviewed games employed a combination of strategies in their design, so it was not obvious which particular strategy led to the observed behaviour change or exerted the most effect on the target audience. There was no tailoring in the selection of strategies used for each individual player.

2.2.2 Game-based interventions for disease management

Games have also been used to help patients improve health-related self-management skills. These include teaching them how to manage certain illnesses, helping them comply with treatment directives by delivering health-related information, modeling and simulating health behavior, and providing opportunities for players to rehearse health behaviors in relation to a specific health condition/illness (Kato 2010). Games in this category are targeted at those who consider themselves ill with the intention of helping them manage their illness or get well. For example, *Packy and Marlon* is an adventure game that helps children and teenagers self-manage their type 1 diabetes. The player's goal is to keep their characters' diabetes under control by monitoring blood sugar, providing insulin, and managing food and other related illnesses (Brownson and Kumanyika 2007). Packy and Marlon is modeled against diabetes challenges. To win, each of the two players—Packy and Marlon—have to successfully manage their insulin and food intakes; therefore they must support each other—*collaboration.* At the beginning of the game, players can set their desired insulin option, fix dose—*customization*, and monitor the fluctuation in blood glucose in response to their behavior choices in the game—*self-monitoring* and *simulation*. Similarly, *Bronki the Bronchiasaurus* is a role playing adventure game aimed at imparting asthma management skills on young children with asthma (Lieberman 2001). The game impacts skills for self-monitoring and simulates good and bad real-world asthma self-management skills. The game presents two animated characters (Bronkie and Trakie), and tasks players with helping the in-game characters keep their asthma at bay by avoiding triggers such as dust and smoke while they go on their quest, measuring and monitoring breath strength—*self-monitoring*, taking medications as needed, and using the inhaler correctly. The character's health outcome is dependent on the player's health decision in the game—*simulation*—and a good health outcome is needed to win the game—

competition. Finally, *SpiroGame* is an interactive game for facilitating spirometry in children (Vilozni et al. 2001). Spirometry is a measure of lung function and it is often used for patients with lung diseases, such as asthma. Spirometry is difficult to perform on young children; however, *SpiroGame* has been shown to improve a child's cooperation during spirometry and hence the successful measurement of lung functioning. It teaches children to differentiate between inhalation and exhalation and to control their breathing during testing by making them use their breath to control a simulated caterpillar that crawls to an apple—*simulation*. To reward their performance, a new picture is displayed—*reward*.

The examples discussed above show how game-based interventions can be strategically designed not only to motivate preventive health behaviour, but also to train and impact skills for disease management and treatment using various techniques. However, most of the existing game-based interventions adopt a one-size-fits-all approach in their design, even though research has shown that players differ in both behavior and motivation (Chen 2008; Orji et al. 2013; Yee et al. 2012). Although some of the games tailored their recommendations based on the user's characteristics (e.g., weight, height), none of the games considered tailoring the underlying strategies. Using an inappropriate strategy can constitute a major barrier to change (Kaipainen et al. 2012).

2.3 Gamer types

Although the recent years have witnessed the emergence of many personality models, the concept of personality type has been traditionally associated with Myers-Briggs Type Indicator (MBTI) (Myers and McCaulley 1985). The MBTI uses four bipolar axes—each representing two opposite psychological types—to classify individuals into one of the sixteen types. The axes are *Introversion (I) versus Extroversion (E), Sensing (S) versus Intuition (N), Thinking (T) versus Feeling (F),* and *Judgement (J) versus Perception (P)*. An individual is classified based on the scores in the four axes. For example, an individual whose score suggests a preference for Extroversion, Sensing, Thinking, and Judgement would be classified as ESTJ. The MBTI has been criticized as a type theory because it assumes that various personality types are mutually exclusive and therefore, asserts that there are unique categories into which individuals can be reliably sorted. The critics of type theories claim that this is not a viable assumption (Bateman et al. 2011). They speak in favor of trait-theories such as the Five Factor Model (FFM) (Goldberg 1993). The FFM is currently the leading and most widely model adopted by personality psychologists. The FFM highlights five personality traits—*openness, conscientiousness, extraversion, agreeableness,* and *neuroticism*. Attempts have been made to apply the FFM to predict game players' satisfaction, however, the results have been inconsistent (Bateman and Boon 2005; Teng 2009; Zammitto 2010), raising doubts regarding the effectiveness of FFM for players' personality modelling in games (Bateman and Boon 2005; Bateman et al. 2011). For example, in a study of gamer type personality and game preference, Zammitto (2010) found that the FFM personality factors only explained 2.6–7.5 % of game preference. A possible explanation for this low predictive capability of FFM in games is provided by Teng (2009) who noted that if personality measures obtained in a game context differ from those obtained in a real life context, then the validity of FFM would be 'irreparably disrupted' (Bateman et al. 2011). According to Bateman et al. (2011), "the comparative failure of FFM in game studies demonstrates the needs for trait models of play rather than adaptations of psychological instruments to game contexts". Consequently, attempts have been made to classify gamers into various personality types commonly referred to as gamer types. The Bartle four gamer types (*Achiever, Explorer, Socializer,* and *Killer*) is the most prevalent gamer personality type (Bartle 1996). However, Bartle's types have significant problems, which include that Bartle asserts that the four gamer types are mutually exclusive. Again, Bartle's model is not empirically based and therefore, cannot be validated (Dixon 2011; Yee 2005). These problems make Bartle's model unsuitable as a general framework for player typology (Bateman et al. 2011). Following Bartle's discussion on player types in massively multiplayer games, Yee (2006) in his investigation on why Massively Multiplayer Online Role-playing Games (MMORPG) appeal to players revealed five main motivations for play: *Achievement, Relationship, Immersion, Escapism,* and *Manipulation.* Although Yee's game play motivation is very useful in guiding game design and most importantly for building a quantitative measure of Bartle's model, it has limited relevance as a general player typology (Nacke et al. 2014). A common shortcoming of both Yee's and Bartle's approaches is their narrow focus on massively multiplayer games, which limits their application as a general model of play (Nacke et al. 2014). Bateman and Boon (2005), in an attempt to develop a more generalizable model of game players, developed the *first Demographic Game Design model* known as DGD1 which was an adaptation of the MBTI typology to games. The four DGD1 player styles include *Conqueror, Manager, Wanderer,* and *Participants*. The DGD1 play styles are not significantly related to the Bartle types. Although, DGD1 presents an interesting model that is more generalizable beyond massively multiplayer games, it is based on the MBTI Model which has been criticized as a type theory and therefore, may no longer be a viable proposition (Bateman et al. 2011). As such, the limitations of MBTI may also extend to DGD1.

An attempt to establish a player typology that is based on play-specific foundations gave birth to the BrainHex model of seven gamer types (Bateman and Nacke 2010).

Although a relatively new model, BrainHex is based less on intuition, and more on neurobiological foundations; in addition, it has been validated with large numbers of participants (Nacke et al. 2011). The BrainHex model identifies 7 types of players.

Achievers are goal-oriented and motivated by the reward of achieving long-term goals (Nacke et al. 2011). Therefore, an achiever often gets satisfaction from completing tasks and collecting things (e.g., points).

Conquerors are challenge-oriented. They enjoy struggling against impossibly difficult foes before eventually achieving victory and beating other players (Nacke et al. 2011; http://blog.brainhex.com/). They exhibit forceful behaviors and channel their anger to achieve victory and thus experience fiero (expressions of pride and emotion following victory).

Daredevil s are excited by the thrill of taking risks and enjoy playing on the edge. They enjoy game activities such as navigating dizzying platforms and rushing around at high speeds while still in control.

Masterminds enjoy solving puzzles, devising strategies to overcome puzzles that defy several solutions, and making efficient decisions.

Seekers enjoy exploring things and discovering new situations. They are curious, have sustained interest, and love sense-simulating activities.

Socializers enjoy interacting with others. For instance, they like talking, helping, and hanging around with people they trust. Socializers are trusting and can be easily angered by people who abuse their trust.

Survivors love the experience associated with terrifying scenes and enjoy the excitement of escaping from terrifying situations.

BrainHex is of particular interest in our work because unlike Bartle's model, BrainHex is empirically based and therefore can be validated. The BrainHex model acknowledges that the gamer types are not mutually exclusive, therefore, scores from each type is summed to find the players dominant gamer type (primary type) and sub types. It describes each gamer's play style and clearly connects it to the types of gameplay elements that the gamer prefers. Moreover, the instrument used to classify participants into gamer types does not require them to introspectively choose their gamer type from a number of categories; BrainHex includes 28 questions about game playing to classify participants into dominant gamer types. This allows for more accurate classification.

2.4 Tailoring persuasive strategies to users and user groups

People differ in motivation and belief about health and what constitutes a healthy life (Orji et al. 2013). Kaptein et al. (2012) in their study of the effect of tailored, randomly-selected, and contra-tailored strategies for motivating healthy snacking discovered that the contra-tailored strategies led to strong adverse reactions from the users, which could increase the unhealthy behavior that the intervention intends to decrease. Following from this observation, they concluded "while persuasive text-messages can be effective in changing people's behaviour and attitude, these changes depend on the right choice of influence strategy for the right participant". Finally, they proposed tailoring persuasive applications to individuals using their *Susceptibility To Persuasion Scale* (STPS). Their study suggests that the success of many PT applications depends on establishing a match between user or user group and the employed strategies. Their study also exemplified how PT applications can be tailored to individuals.

Undoubtedly, tailoring to individuals maximizes the influence and the effectiveness of PT interventions; however, it may not be achievable in most cases because of the cost of developing sufficiently rich user models and possible spectrum of adaptations. As a result, researchers have begun to examine ways of tailoring PT interventions to various user groups and sub-groups based on some common user characteristics. Kaptein et al. (2010) investigated the hypothesis that cultural background is a significant characteristic for tailoring PT interventions in a game called *Smoke?* To tailor the game to various cultural groups, the authors developed two versions of the game (one for a collectivist and one for an individualist culture) using strategies that are deemed appropriate for each group. The result of the evaluations showed that individualist players were persuaded more by the individualist version of the game than when playing the collectivist version. Halko (2010) conducted an exploratory study of the influence of some strategies, and identified that certain strategies were preferred more by users of particular personalities while others were not. Hence, they concluded that the Five factor personality traits Model (FFM) (Goldberg 1993) captured important characteristics for tailoring strategies to better fit the needs of the users (Halko 2010). Similarly, Hirsh et al. (2012) examined if 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 (Goldberg 1993) was an effective way of increasing the impact of the message on the recipient. Along these lines, Arteaga et al. (2009) employed the FFM to tailor persuasive mobile games to various users' personalities. At the beginning of the game section, users responded to a questionnaire to determine their personality. The personality information was then used to inform the choice of game recommended to the users and the motivational strategy used in the game. Arteaga's study showed some interesting relationships between personality traits, games, and motivational strategy preference (Arteaga et al. 2012). Although several persuasive researchers have adopted the FFM to tailor their applications, the adequacy of FFM for tailoring persuasive games has been questioned (Bateman et al. 2011). Therefore, researchers have focused on alternative approaches for tailoring persuasive games. For example Tan et al. (2013) examined the effectiveness of tailoring feedback in a persuasive game to various personality types ranging from introversion to extroversion and found that tailored feedback significantly improved player experience. Another example of tailored persuasive games can be seen in the design of a physical activity motivating game called *PLAY, MATE!* (Berkovsky et al. 2010). To minimize the variability in the perceived enjoyment and amount of activities performed by novice and experience players, PLAY MATE! tailored the rewards and personalized the difficulty level by adjusting the reward times for novice and experienced players. The tailoring balanced the number of activities performed by novice and experienced players without affecting the perceived enjoyment. PLAY MATE! tailored the strategies by varying the time required to complete a task between novice and experienced gamers; however, the same strategy—reward—still applied to every player. We argue that some strategies may be unsuitable for some groups of players and therefore should be avoided, while other suitable strategies should be emphasized.

As can be seen from the above discussion, most existing work has focused on tailoring PT using the FFM. This suggests that significant homogeneity exists among people that belong to the same personality type and the same or similar persuasive approach can be employed to target them.

In this paper, we focus on game-based persuasive interventions. According to Berkovsky et al. (2012), tailoring strategies has a "huge untapped potential to maximize the impact of persuasive applications"; however, research into the various ways of tailoring strategies is only starting now. One of the ways persuasive games could be personalized is to tailor the strategies to various players' personalities, often referred to as *gamer types*. Although attempts have been made towards personalizing persuasive games, game player models have largely been ignored as a dimension for distinguishing different types of users. Yet, gamer type is a good choice for group-based personalization, because players belonging to one gamer type share common characteristics that cause them to approach games in a similar manner and enjoy similar types of games; there is a homogeneity within a group that is mainly different from players of other gamer types (Bateman and Nacke 2010). Research (Orji et al. 2013) has shown that gamer type moderates the influence of various health determinants and hence, is an important characteristic for tailoring persuasive games. Hence, there is a need for research on ways of tailoring persuasive game interventions to various gamer types.

In summary, our review of related work shows that persuasive games have gained popularity as an innovative approach for motivating change in health behavior. However, most of these games adopt a one-size-fits-all approach in their intervention design. One way that persuasive games can be tailored is to adapt the strategies to player personality, often referred to as their gamer type. The success of many persuasive interventions will depend on establishing a match between user or user group and the employed strategies. In this paper, with the aim of developing guidelines for tailoring persuasive games interventions to various gamer types identified by BrianHex, we investigate and compare the persuasiveness of ten commonly employed strategies.

3 Study design and methods

Our study was designed to investigate the perceived persuasiveness of the ten strategies (customization, simulation, self-monitoring, suggestion, personalization, simulation, praise, reward, comparison, competition, and cooperation) for motivating healthy behavior (specifically healthy eating) for the seven gamer types—Achiever, Conqueror, Daredevil, Mastermind, Seeker, Socializer, and Survivor. In this section, we first describe how we developed the research instrument; this is followed by data collection methods and validation.

3.1 Measurement instrument

To collect data for our model, we follow the approach described by Halko (2010). Specifically, we represented each persuasive strategy in a storyboard about a persuasive game for motivating healthy eating. The ten storyboards were drawn by an artist and were based on storyboard design guidelines by Truong et al. (2006). Although we could have implemented the individual strategies and then evaluated their suitability in applications, we chose to use storyboards for three main reasons. First, it is easier to elicit responses from diverse populations because storyboards provide a common visual language that individuals from diverse backgrounds can read and understand (Lelie 2005). Second, it is easier to collect a large volume of data needed for building and validating our model of persuasiveness of the ten strategies for the seven gamer types. Third, storyboards have been shown to be effective at depicting strategies in previous research (Halko 2010). Finally, actual implementation may create additional noise as it involves many other design decisions and the results can easily be biased by specific implementation decisions, while the storyboard allows us to show in an "ideal" form the essence of persuasive interaction. The storyboards show a character and his/her interactions with a persuasive game application for promoting healthy eating. The storybaords and other measurement instruments are included in "Appendix".

To elicit feedback on the persuasiveness of the strategies, each storyboard is followed by a validated scale for measuring perceived persuasiveness. The scale was adapted from Drozd et al. (2012). The scale consists of four questions. A sample question includes: "The system would influence me", "the system would be convincing, "the system would be personally relevant for me", and "the system would make me reconsider my eating habits". The questions were measured using participant agreement with a 7-point Likert scale ranging from "1 = Strongly disagree" to "7 = Strongly agree". We also included an open-ended question allowing participants to provide comments about each strategy. Prior to assessing the persuasiveness of the various 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 ten 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"). Responses from participants who answered both comprehension questions incorrectly were discarded. Together with responses from participants who gave correct answers to the two comprehension questions, we also retained responses from participants who answered one of the comprehension questions correctly. We also included 28 BrainHex questions to classify the participants into various gamer types; questions for assessing the participants' demographic information, and eating behavior were also included. The detailed instrument used for the study is included in "Appendix".

3.2 Data collection and filtering

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 (Buhrmester 2011; Halko 2010; Heer and Bostock 2010; Hirsh et al. 2012; Lewis et al. 2011; Mason and Suri 2012); and second, we needed a large participant sample and diverse audience for our study. AMT allows access to a global audience at a relatively low cost, and ensures efficient survey distribution, and high quality results (Buhrmester 2011; Mason and Suri 2012). We followed the recommendations for performing effective studies on AMT by Mason and Suri (2012), and used a similar approach to the one described by Halko (2010) to overcome potential problems associated with recruiting from AMT, such as the issue of mechanical bots completing a survey. Specifically, we used captcha to ensure that only human participants are retained in our survey. We ensured that participants could respond to our study only once using a mechanism provided by AMT that allows collection of response from unique participants. We also examined the workers' identifications provided by the AMT which further ensured that no duplicate responses were received. In addition to the use of two comprehension questions (discussed previously), we also included time stamps to ensure that participants did not game our study by completing it without reading or understanding. We tracked the total time taken by participants to complete the survey. The study took an average of 30 min to complete. The responses from participants who completed before a threshold time—20 min—were discarded. Furthermore, we employed attention questions to ensure that participants were actively considering their answers. Specifically, we injected some irrelevant questions—constructed to be closely related to other questions in the same section—and clearly indicated what participants should do if they were reading the questions. For example, having the question: "*Fighting and quarrelling with everybody. If you are reading this question select I hate it*" as one of the questions following an instruction "*Rate each of the videogame experiences listed. Choose from a scale between 1—"I love it!" for experiences you enjoy through 3—"It's okay" to 5—"I hate it!" for experiences you would rather avoid"*. Responses from participants who got the attention questions incorrect were also discarded. We collected a total of 1,384 responses and retained a total of 1,108 valid responses, which were included in our analysis.

To eliminate possible bias due to the ordering of the storyboards in the survey, we used a Latin Square to balance the order of presentation of the strategies. We created ten surveys that varied the position of each strategy and randomly assigned participants to one of the ten surveys.

Before the main study, we conducted two pilot studies. The first pilot study was conducted on 30 participants (15 participants from AMT and 15 participants recruited from a university in Canada) to test the validity of our study instruments and to compare the results. The preliminary evaluation shows similar results from the participants recruited from AMT and those from the university; however, it also revealed a need to restructure some of the study questions. We restructured the questions and conducted a second pilot study on another 5 participants using the think aloud approach. The second pilot confirmed the suitability and understandability of our study instrument.

3.3 Participants' demographic information

A total of 1,384 participants responded to our study and their demographic information is summarized in Table 1. The participants received \$1 USD dollar compensation, which is within the range of the standard rates for other tasks recruited through AMT. In general, we have a relatively diverse population in terms of gender, age, education level attained, and gamer types. Half of our participants play games every day and over 60 % of our participants are from the United States.

3.4 Data analysis

The main aim of this paper is to examine whether significant differences exist across the gamer types with respect to their perception of various strategies and to develop guidelines for tailoring strategies to individual gamer types. This entails examining the relationship between the persuasiveness of various strategies and the seven gamer types identified by BrianHex. To achieve this, we used several well-known analytical tools and procedures. In this section, we summarize the various steps taken to analyse our data.

1. We validated that our storyboards correctly depicted the intended strategy using a Chi-squared test (Halko 2010).

Table 1 Participants' demographic information

Total participants = 1,108	
Gender	Females (533, 48 %), males (575, 52 %)
Age	18–25 (418, 38 %), 26–35 (406, 37 %), 36–45 (168, 15 %), over 45 (116, 10 %)
Education	Less than high school (12, 1 %), high school graduate (387, 35 %), college diploma (147, 13 %), bachelor's degree (393, 35 %), master's degree (141, 13 %)
Country	Canada (40, 4 %), India (148, 13 %), Italy (23, 2 %), United States (714, 64 %), United Kingdom (38, 3 %), others (145, 13 %)
Gamer types	Achiever (176, 16 %), Conqueror (131, 12 %), Daredevil (114, 10 %), Mastermind (331, 30 %), Seeker (153, 14 %), Socializer (101, 9 %), Survivor (102, 9 %)
Frequency of game play	Every day (549, 50 %), few times per week (410, 37 %), once per week (53, 5 %), few times per month (52, 5 %), once per month (16, 1 %), few times per year (26, 2 %), once per year or less (2, 0 %)

2. We determined the suitability of our data for factor analysis using the Kaiser–Meyer–Olkin (KMO) sampling adequacies and the Bartlett Test of Sphericity (Kaiser 1970). Given these positive results, we determined that the data was suitable to conduct factor analysis (Hinton et al. 2004; Kaptein et al. 2012).
3. Because the individual strategies have not been validated together before, we performed EFA to determine the number of factors available in our study (Costello et al. 2011).
4. After we established that some differences exist, we employed the PLS-SEM (Ringle et al. 2005) to create models showing the relationships between the gamer types and the persuasiveness of various strategies.
5. To establish that gamer type is a reliable characteristic for tailoring persuasive games, we performed multi-group comparison using the pairwise approach recommended by Chin (2012). Specifically, we examined the models for significant differences across the seven groups.
6. We employed the Bonferroni–Holm adjustment to control any familywise Type 1 error due to multiple comparisons (Holm 1979). The result showed that the observed differences in the relationships between the gamer types and the persuasiveness of various strategies were statistically significant.
7. Finally, we describe how we classified participants into discrete gamer types, using the dominant BrainHex class (http://blog.brainhex.com/). For readers interested in the details of the analysis process, information on each of these steps is provided in the following subsections; whereas, the results of the modeling process are described in Sect. 4.

3.4.1 Storyboard validation

To ensure that participants understood the intended persuasive strategy in each the storyboards, we ran Chi-squared tests on the participants' responses to the multiple-choice questions that required them to identify the represented persuasive strategy for each of the storyboards. The results for all the strategies were significant at $p < .001$, which indicates that the storyboards were understood by the participants and that the storyboards successfully depicted the intended strategies (Halko 2010).

We discarded incorrect responses before running the Chi-squared tests because we had more than one elimination criteria; however, it is worth noting that only 27 participants were eliminated due to incorrect identification of the strategies—the majority of the participants were eliminated due to an incorrect response to the attention questions or incomplete response. Having a p value of 0.001 is good enough that even if we added the 27 responses discarded, the Chi-squared result would still be significant (at 0.05 in the worst case scenario).

3.4.2 Measurement validation

We determined the suitability of our data for factor analysis using the KMO sampling adequacies and the Bartlett Test of Sphericity. Our results showed that the KMO was 0.959, well above the recommended value of 0.6; that the Bartlett Test of Sphericity was statistically significant ($\chi^2(780) = 67{,}805.9$, $p < 0.0001$); and that all of the communalities were well above .3. These results show that our data were suitable for factor analysis (Grimes et al. 2010; Henseler et al. 2009).

To determine the appropriate number of factors in our data, we performed EFA—a statistical procedure that identifies the number of latent factors in a set of variables—using Principal Component Analysis (PCA). We first examined the eigenvalue against the component number and considered factors with an eigenvalue of at least 1 (Kaiser 1960). As shown in Table 2, there are eight factors with an eigenvalue of at least 1 and the eight factors explained a total cumulative variance of 85 %, which is very high for multidimensional constructs. We further examined the eight-factor solution using Oblimin rotation (Brown 2009). Table 3 gives an overview of the loadings of each of the items on the components. All 40 items (four questions for each of the ten strategies) were retained and included in our analysis because all the items have factor loading greater than 0.30 and cross loading less than 0.30. The 0.30 level is an accepted

Table 2 Eigenvalue and total variance explained—factors with Eigenvalue less than 1 have been removed

Component	Initial eigenvalues ≥1			Rotation sums of squared loadings
	Total	% of variance	Cumulative %	Total
1	21.788	54.470	54.470	12.151
2	3.252	8.129	62.599	14.171
3	2.491	6.227	68.827	11.372
4	1.640	4.099	72.926	10.502
5	1.396	3.491	76.417	11.756
6	1.334	3.335	79.752	13.720
7	1.182	2.955	82.707	13.131
8	1.082	2.704	85.411	11.837

Table 3 Factor loadings based on principle component analysis with oblimin rotation of the 40 items measuring persuasiveness of the 10 strategies

	Comp.1	Comp.2	Comp.3	Comp.4	Comp.5	Comp.6	Comp.7	Comp.8
SEMT1	.823							
SEMT2	.842							
SEMT3	.817							
SEMT4	.826							
SUGG1	.431							
SUGG2	.398							
SUGG3	.380							
SUGG4	.404							
CMPR1		.868						
CMPR2		.872						
CMPR3		.866						
CMPR4		.883						
CMPT1		.765						
CMPT2		.732						
CMPT3		.759						
CMPT4		.775						
CUST1			.942					
CUST2			.948					
CUST3			.902					
CUST4			.894					
REWD1				.877				
REWD2				.860				
REWD3				.883				
REWD4				.857				
PERS1					.841			
PERS2					.841			
PERS3					.829			
PERS4					.828			
COOP1						.940		
COOP2						.932		
COOP3						.872		
COOP4						.865		
SIML1							.830	
SIML2							.881	
SIML3							.852	
SIML4							.826	
PRAS1								.701
PRAS2								.745
PRAS3								.766
PRAS4								.776

Comp components, *CMPT* competition, *CMPR* comparison, *COOP* cooperation, *CUST* customization, *PERS* personalization, *PRAS* praise, *SEMT* self-monitoring, *SUGG* suggestion, *SIML* simulation, *REWD* reward

Table 4 Overview of the mean score, standard deviation, Cronbach's alpha of each of the strategies scales

Factors	# of questions	Mean (SD)	Cronbach's α
Cooperation	4	4.41 (1.76)	.957
Competition and comparison	8	4.40 (1.72)	.961
Customization	4	3.35 (1.75)	.957
Personalization	4	4.84 (1.64)	.958
Praise	4	4.21 (1.75)	.966
Reward	4	3.91 (1.82)	.967
Self-monitoring and suggestion	8	4.31 (1.59)	.958
Simulation	4	4.62 (1.73)	.964

minimum loading because it indicates that the factor explained at least 10 % of the variance in the corresponding variable (Tinsley and Tinsley 1987). The PCA shows that the ten strategies loaded into eight different factors. As expected, most of the final factors represent a single persuasive strategy; however, self-monitoring and suggestion loaded into the same factor (component 1), and, competition and comparison loaded to the same factor (component 2). This suggests that our participants perceived these strategies as being similar. We further discuss these two groupings in the results section. Consequently, we treat competition and comparison as one factor and self-monitoring and suggestion as one factor. Hence, the total number of factors considered in this study was reduced from ten to eight. We present the description of each of the factors extracted from the PCA in Table 4.

3.4.3 The measurement model

After determining the number of factors in the data using PCA, we employed the PLS-SEM to develop models showing the persuasiveness of the ten health-behavior motivating strategies for various gamer types. SEM is a recommended approach for modeling of relationships between variables (Kupek 2006) and it has been successfully used in building models and estimating relationships between various personality types and several technological and behavioral factors (e.g., see Echchakoui 2013; Hirsh et al. 2012; Ong and Musa 2012). PLS is a prediction-oriented approach to SEM that has less stringent requirements concerning data distribution assumptions (Henseler et al. 2009). It can accommodate small sample sizes, as opposed to covariant-based SEM. We chose PLS over a covariant-based approach (e.g., LISREL) because it is highly appropriate for complex predictive models (Baron and Kenny 1986). Specifically, we used SmartPLS 2.0 (M3) (Ringle et al. 2005) in estimating our model. We argue that PLS-SEM is the most appropriate statistical technique to utilize in our research, because the constructs in our research model have not been tested together.

As recommended by Anderson and Gerbing (1988), we validated the measurement model before estimating the structural paths to test for the relationship between the variables using the criteria suggested by Chin (1998). PLS-SEM assesses the property of scales in terms of convergent validity, discriminate validity, and composite reliability. We report here the common set of indices recommended for model validity and reliability in PLS. Using criteria from Chin (1998) and Fornell and Larcker (1981), indicator reliability can be assumed because Cronbach's α—see Table 4—and the composite reliability that analyzes the strength of each indicator's correlation with their variables are all higher than a threshold value of 0.7. Convergent and discriminate validity can be assumed as all constructs have an Average Variance Extracted (AVE) (which represents the variance extracted by the variables from its indicator items) above the recommended threshold of 0.5 and greater than the variance shared with other variables (Chin 1998; Fornell and Larcker 1981). The measurement models yielded an acceptable value of all indices for PLS model validity and reliability.

Prior to comparing our models, we tested for measurement invariance across the seven gamer types. This is important because the psychometric properties of the samples must be demonstrated to have the same structure to establish that the gamer types had similar interpretations of our instrument's items. A failure to establish measurement invariance would suggest that we have measured different phenomena across the sub-groups, and therefore makes comparison between sub-groups using our data not worthwhile (Setterstrom and Pearson 2012). To assess measurement invariance, we used the Component-based Factor Analysis (CFA) in SmartPLS 2.0 (M3) (Ringle et al. 2005) to conduct factor analysis for each sub-group of data and retained items that had factor loadings of at least .5 (Hair et al. 2011) in all the sub-groups (and dropped items with loadings less than .5 for all groups) thereby establishing configural invariance. After configural invariance was established, we also assessed and established metric (equivalent factor loadings) and scalar invariance (equivalent intercepts) by first running bootstrap analyses using a resample size of 1,000, and generating the standard error (SE) for each item's weight in each sub-group. Next, we ran the PLS algorithm for each sub-group and recorded the actual weight. We calculated t-statistics and the corresponding p value to see if there were significant differences across the sub-group (at $p < .05$) using the weight, SE, and sample size in each sub-group. Items that were significantly different were dropped for all sub-groups. This process established measurement invariance and ensured that our data were suitable for multi-group comparison (Setterstrom and Pearson 2012; Steinmetz et al. 2008).

3.5 Gamer type reliable characteristics for tailoring

To examine the differences and similarity in the perception of the ten strategies by the seven gamer types, we separately modeled the efficacy of each strategy for each gamer type. Gamer type was chosen through the BrainHex method (BrainHex 2012), which yields a score for each of the seven types for each individual. By choosing the dominant type, we classified the participants into one of the seven types. Although an individual can have an affinity with more than one gamer type, a single type generally emerged as dominant type from our study.

To establish that gamer type is a reliable characteristic for tailoring persuasive games, we assess for significant structural differences between the models for each gamer types using the pairwise comparison approach recommended by Chin (2012).

Table 5 Standardized path coefficients (β)

Gamer type	Strategies							
	CMPT/CMPR	COOP	CUST	PERS	PRAS	SEMT/SUGG	SIML	REWD
Achiever	–	.15	–	–	–	.10	–	.10
Conqueror	.25	-	–	.12	–	.12	.14	–
Daredevil	*−.10*	–	–	–	–	*−.14*	.11	–
Mastermind	.12	–	.10	.12	-	.14	.12	–
Seeker	.10	–	.19	.11	.10	–	–	–
Socializer	.11	.17	*−.12*	–	*−.12*	*−.13*	–	–
Survivor	.17	*−.20*	*−.13*	–	–	.27	–	*−.14*

All displayed coefficients are significant at $p < .05$, whereas '–' represents non-significant coefficients. The negative coefficients are italicized
CMPT/CMPR competition and comparison, *COOP* cooperation, *CUST* customization, *PERS* personalization, *PRAS* praise, *SEMT/SUGG* self-monitoring and suggestion, *SIML* simulation, *REWD* reward

Specifically, we used PLS algorithm in SmartPLS to separately estimate the path coefficient (β) for each group. Then, we used the bootstrap resampling technique to calculate standard error (SE) for each structural path. With the β, SE, and the sample size, we calculated t-statistics and their corresponding p value used in testing for significant differences between path estimates of the gamer types. Again, following the pairwise comparison, we controlled for any possible familywise type I error (due to multiple comparisons) using the Bonferroni–Holm adjustment. We found significant differences across the gamer types; therefore, we establish that gamer type is a reliable characteristic for tailoring persuasive games.

4 Results and interpretation

In this section, we present the results of the structural models and interpret the findings. As noted previously, we created seven models—one for each gamer type. Individual participants were included in only one model. For details on the modeling process, see the previous section. We further discuss the findings in the general discussion.

4.1 The structural model

The structural models determine the perception of various strategies by modeling the relationship between the gamer types and the strategies. An important criterion to measure the strength of the relationship between variables in structural models is to calculate the level of the path coefficient (β) and the significance of the path coefficient (p) (Hair et al. 2011). 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 5.

4.2 Persuasiveness of the strategies for the seven gamer types

The results from our models show that the seven gamer types—achiever, conqueror, daredevil, mastermind, seeker, socializer, and survivor–differ with regards to the persuasiveness of the strategies (competition and comparison, cooperation, customization, personalization, praise, self-monitoring and suggestion, simulation, and reward), see Table 5. In this section, we discuss and compare the perceptions of strategies by the gamer types.

4.2.1 Competition and comparison

Competition and comparison are among commonly used strategies in PT intervention design in general and in persuasive games design specifically (for e.g., see Bell et al. 2006; Fujiki et al. 2008; Li and Counts 2007; Orji et al. 2012). The Persuasive System Design (PSD) framework enlisted competition and comparison as two separate PT design strategies; however, the result from the PCA shows in fact that they belong together. This is understandable, since in most real life situations, competition is often a by-product of comparison. In most PT interventions, competition and comparison is often an explicit design goal or a consequence of how the system is used (Grimes et al. 2009). In any case, the increasing use of competition and comparison is based on the assumption that humans are competitive beings and have the natural drive to compete (Oinas-Kukkonen and Harjumaa 2008). Therefore, users will be motivated to perform better if given an opportunity to compare and compete with others; especially when the others are similar to them (e.g., peers) (Fogg 2003). In line with the general assumptions, the results from our models show that competition and comparison is perceived positively by all gamer types except achiever and daredevil. As shown in Table 5, conqueror, mastermind, seeker, socializer, and survivor are significantly positively associated with competition and comparison ($\beta = .25$), ($\beta = .12$), ($\beta = .10$), ($\beta = .11$), and ($\beta = .17$) respectively. In line with this finding, many participants in our study endorsed this strategy and expressed how it would motivate them if properly included as part of a game. For example, a participant commented that, "*Competition is the best motivation, there would need to be system so that people couldn't cheat …*". "*With this competition, I see this game becoming addictive, I hate to be beaten and will do anything to win*".[1]

Competition and comparison showed no significant relationship with the achiever gamer type, while daredevil is the only type that perceives competition and comparison as negative ($\beta = -.10$). The explanation to these results can be found in the characteristics of the gamer types. Achievers are goal oriented and positively incentivized by reward (BrainHex 2012) or recognition that demonstrates their success in the game; this is confirmed by their significant positive association with reward in our study. However, an achiever who is obsessed with achievement in a game may not be motivated to compete and compare with other players because there is a chance that she may be defeated. Similarly, a daredevil is inclined to thrill seeking, while at the

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

same time maintaining control. Similar to the achiever, competition and comparison has the tendency of not only making one lose control, but also confining people to their comfort zone and avoiding exploration and thrill seeking. This explains why daredevils perceive competition and comparison as negative and might try to avoid any game based on this strategy. Again, once competition is introduced, people tend to avoid trying new things for fear of losing. On this note, a participant with a high daredevil score gave this comment "*Competition is not the way to go, it makes me stick to one thing. I counted calorie and lost my balance diet! .... I will not use this app!*". A participant with a high achiever score gave this comment " ...*Comparing and competing with your friends is extremely dangerous. I've a personal experience with calorie counting app that almost cost me my relationship with my friend because she was wining and I felt terrible*". These results imply that employing competition and comparison in persuasive games to motivate behavior performance may in fact have no impact on achievers and can actually deter daredevils from playing the game and hence performing the intended behavior. The result is in line with previous research that found that users were uncomfortable with using competition to motivate behavior in a health application (Grimes et al. 2009; Toscos et al. 2006), and may even become demotivated if they lose (Bell et al. 2006). For example, during an evaluation of persuasive technology intended to encourage family reflection, participants worried that comparing the health behaviors and measures of different family members could lead to negative comparison and competitiveness (Grimes et al. 2009). The tendency of competition and comparison to demotivate behavior for some people is summarized in a statement by Kohn (2006), which says "to say that an activity is structurally competitive is to say that it is characterized by what I will call mutually exclusive goal attainment. This means, very simply, that my success requires your failure."

4.2.2 Cooperation

According to the PSD framework, "a system can motivate users to adopt a target attitude or behavior by leveraging human beings' natural drive to co-operate." (Oinas-Kukkonen and Harjumaa 2008). This is different from competition and comparison because achievement depends on group effort. Although not as frequently used as competition and comparison, it has been employed by a number of persuasive game applications for health, see for example Bell et al. (2006). The major assumption is that group members will encourage each other to perform better for mutual benefits like recognition and winning, which in turn leads to target behavior performance.

The results from our study show however, that cooperation is only a significant motivator of behavior change for achievers and socializers with ($\beta = .15$) and ($\beta = .17$) respectively. This is in line with the gaming style of socializers, who enjoy helping others. Achievers would also prefer to cooperate because they are inherently more altruistic. According to Bartle (1996) "achievers do often co-operate with one another, usually to perform some difficult collective goal, and from these shared experiences can grow deep, enduring friendships which may surpass in intensity those commonly found among individuals other groups." This is further confirmed by comments from participants with high achiever and socializer tendencies: "*This is the best of the systems in my opinion because the more people with the same goal, the more power there* *is available in achieving that goal in many ways including support and moral boosting for one another*". "*I really like this idea of cooperation rather than competition. This is a good way for motivating others to lose weight and help them along the way while at the same time building and maintaining relationship*". These results are also in line with previous research that found that playing in teams increased members' motivation and behaviour performance as members shared vital information on how to reach their goals (Bell et al. 2006).

On the other hand, introducing cooperation demotivates survivors ($\beta = -.20$). This could be explained by the fact that in cooperative games, rewards are often based on collective performance—a player can succeed only if the others also succeed. As result, survivors—who enjoy the thrill of escaping from scary situations—may be frustrated if they get pulled down after putting effort into the activity. According to some participants: "*This may lead to strained relationships. If I put much effort and feel that the other person does not always make full effort to reach the daily goal, things could get tensed*"; "*…even worse than competition, I'd barely even use it. I don't like to play game and feel obliged to play it (otherwise the other players won't get their points)"; "Not good, if your partner stops caring, you stop caring, now there're two fat people*". This explains why survivors, who enjoy the excitement of escaping from terrifying situations, are not inclined to cooperation, which assumes that we primarily want to help others or need help from others (Kohn 2006).

4.2.3 Customization and personalization

Customization and personalization represent two separate strategies in our model, however we decided to discuss them together to compare and contrast the two strategies that represent two different ways of tailoring interventions.

Tailoring health interventions has been found to have significant positive effects on health behavior change in general (Noar et al. 2007). As a result, researchers have been investigating various ways that applications could be tailored to users, and they identified two different methods of tailoring applications: user-initiated or user tailoring also referred to as *customization,* and system-initiated tailoring also referred to as *personalization* (Sundar and Marathe 2010). It has been argued that tailoring/customization will be more effective when the user is allowed to do it for him/herself, because it imbues users with a strong sense of personal agency, by allowing them to individualise their preference or request (Sundar and Marathe 2010). According to Sundar et al. (2012), "while system-tailoring results in content that is relevant to the user, customization produces content that is not only relevant but also of utility to the user, thereby boosting users' agency and self-determination". Several studies found that irrespective of what aspect of the system is customizable, customization makes the user feel like a relevant actor in the technological interaction and builds a sense of identity, autonomy, and control compared to when users are provided with system-tailoring (Sundar and Marathe 2010). Based on these findings, we separated the two types of tailoring—customization and personalization—and studied their persuasiveness. The results from our analysis seem to support the fact that these two strategies are perceived differently by users as they loaded into two different factors and impacted participants differently. Masterminds and seekers perceive both customization and personalization as positive strategies that could motivate them to use the persuasive game to change their behaviors. Conquerors are positively and significantly persuaded by personalization, but not customization. Interestingly, socializers and survivors show negative associations with customization, but show no significant relationship with personalization.

A possible explanation can be found in the distinction between these two strategies—user tailored (customization) versus system tailored (personalization). People who feel threatened by losing control and those who are very 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. On the other hand, other users who are more persuaded by the relevance (and care less about control) of the resulting content tend to use only the default features (Sundar and Marathe 2010). From our result, conquerors belong to the latter group who are significantly motivated by the relevance of content provided by personalization ($\beta = .12$) and care less about control. Similarly, masterminds and seekers are incentivized by both customization ($\beta = .10$; $\beta = .19$) and personalization and ($\beta = .12$; $\beta = .11$). This suggests they could be motivated to use a system by tailoring its content using any of the approaches—whether user-tailored or system-tailored may not be important. On the other hand, socializers and survivors seem not to care about tailoring content; in fact, they are both demotivated by customization ($\beta = -.12$; $\beta = -.13$). A possible explanation is that socializers and survivors may not like to use applications that require a lot of input from them as in the case of customizable applications. This is in line with Sundar and Marathe (2010), which suggests that some users are more comfortable with the default setting and do not like systems that really get them involved.

4.2.4 Praise

Using praise to motivate system usage and behavior change looks trivial, however, it has been elegantly employed by some PT applications to motivate healthy behavior change (for example, see Bang et al. 2006; Toscos et al. 2006). The underlying assumption is that a system will establish a sense of personal relationship with the users and make users more open to persuasion if it praises users for behavior performance via words, images, symbols, and sounds (Oinas-Kukkonen and Harjumaa 2008). The results from our study show that praise is not as important as one might think. It is significantly associated with only two gamer types: seeker and socializer. Praise is perceived as a positive motivator by seekers ($\beta = .10$) while socializers are negatively associated with praise ($\beta = -.12$). The negative relationship of socializers with praise is somehow surprising considering that socializers are characterized by their love for interacting with and getting endorsed by other players. One possible explanation is that socializers might not value praise from system or non-player characters (as they value praise from real players) and may get angered by it. This is supported by a comment from a participant with high socializer tendency: "*of what use is this avatars' praise! I rather get no praise than having this thing deceive me*." Another participant said "*I like getting praised for meeting my goals, automated praise is just not the same thing as real praise from someone I know*". Some other participants view praise as shallow, trivial and not contributing directly to their goal. For example, some participants gave this comment "*...while this is like a virtual reward, getting feedback is more useful than this*", "*It's kind of cheesy but, when a game keeps saying that I'm going well, I start to feel better about myself—my mood is improved and I think good thoughts about myself, but how will that help me eat healthy!*". This explains why praise is not perceived as important by achievers, conquerors, daredevils, masterminds, and survivors.

4.2.5 Self-monitoring and suggestion

In literature, self-monitoring and suggestion has been considered as two different strategies (Oinas-Kukkonen and Harjumaa 2008), but in practice, they are often used together as they seem to complement and enhance each other. An effective suggestion strategy requires context-awareness (Andrew et al. 2007) or monitoring of both the behavior and the opportune moment for suggestion. The analysis of our data reveals that self-monitoring and suggestion are viewed similarly by users—they loaded into the same factor. Therefore we group them together as one variable in our analysis.

Self-monitoring and suggestion are the dominant strategy used in health promoting applications targeted at motivating healthy eating and physical activity (for example see Bell et al. 2006; Consolvo et al. 2006; Fujiki et al. 2008; Toscos et al. 2006; Tsai et al. 2007). This strategy builds on the human needs for awareness and self-understanding. Our results show that self-monitoring is associated with all gamer types except seeker, although to different degrees and direction. For seekers, it may be that because one of the in-game activities that seekers find rewarding is exploration and discovery, a system that makes suggestion will remove this aspect of exploration and discovery. Self-monitoring is significantly and positively related to achiever, conqueror, mastermind, and survivor with ($\beta = .10$), ($\beta = .12$), ($\beta = .14$), and ($\beta = .27$) respectively, while it is perceived as negative by socializer and daredevil ($\beta = -.14$) and ($\beta = -.13$) respectively. The negative perception of self-monitoring and suggestion by socializer and daredevil is in line with other research that recorded some negative reaction and low compliance to applications that employed the self-monitoring strategy because of the labour-intensive nature of the current monitoring tools, especially diet monitoring tools (Brown et al. 2006). Although some recent developments in technology have enabled some automatic diet monitoring, there are still some limitations on what types of food that can be monitored automatically. In most cases, users have to be involved either by entering some of their diet or editing and correcting erroneous data. Some of our participants expressed similar concerns about self-monitoring and suggestion along with the need to carry some additional tools, which may not be convenient. Some participants gave these comments "*Any system where you track every meal can be tedious and I may not want to put in that much effort*" and with regard to suggestion, a participant made this comment "*I personally don't like advice, getting advice from a system feels terrible. That means the system knows more than me!*".

Another possible explanation why socializer is negatively associated with self-monitoring may be because people who have high socializer tendencies tend to strive for self-esteem and might likely avoid anything that might reveal a self that is contrary to the image they hold of themselves. Similarly, daredevil—who enjoys taking risks and playing on the edge—may not care about self-awareness or self-understanding and suggestions on how to improve.

4.2.6 Simulation

According to Fogg (2003) an application can persuade people to change their attitude or behavior if it provides a way for people to observe the immediate cause and effect linkage of their behaviors. Simulation is not among the commonly employed strategies in intervention design for health promotion. Interestingly, from our models, simulation emerged as one of the strategies that is not negatively associated with any gamer type. Specifically, simulation shows some significant positive relationship with the conquerors, daredevil, and mastermind ($\beta = .14$), ($\beta = .11$), and ($\beta = .12$) respectively. This suggests that a persuasive game that is designed to show users the consequences of their behaviors could motivate them to change. This is particularly necessary for PT interventions aimed at motivating healthy behavior. Adopting healthy behavior is a lifestyle that spans over a lifetime and it doesn't have immediately visible consequences. Therefore, people tend to be demotivated from adopting a healthy behavior that has no observable immediate benefit or consequences. Simulating behavior can close this gap as it allows users to visualize and compare outcomes of alternative behaviors over a specified period of time. In line with this, some participants gave these comments about simulation "*I would use this application everyday. I like the fact that it shows how my overall body will look at the end of the desired time. Seeing the result is very motivating to me*". "*This is really awesome app, I like the way it shows the future and tells you how long it will take to reach your goal if you keep eating a certain amount of calories*" and "*I think it would be helpful in aiding the user to imagine his/her future body image. When one can get a clear picture of a goal in one's head I think it is easier to achieve*". All of this suggests the need for applications designed to motivate health behavior to find ways of projecting and making observable the benefits and consequences of a user's behaviour, thus reducing the abstraction that is often associated with the outcome of health behaviors.

4.2.7 Reward

The PSD model states that rewarding target behavior reinforces the behavior and may increase the persuasiveness of a system. Therefore, the system should offer virtual rewards to the user as a credit for performing the target behavior (Oinas-Kukkonen and Harjumaa 2008). As a result, reward is one of the commonly used strategies in applications that motivate health behaviour (for example see, Bell et al. 2006; Fujiki et al. 2008; Li and Counts 2007; Orji et al. 2012; Pollak et al. 2010). However, from our model, reward emerged as the least significant of the eight strategies. Reward is positively associated with only achiever ($\beta = .10$). This is in line with the playing style of achievers. Achievers are interested in completing tasks and collecting all possible rewards (e.g., points). On the other hand, introducing rewards could deter survivors who perceive rewards as negative ($\beta = -.14$). This is not surprising considering that reward has been a controversial strategy because of its focus on extrinsic motivation. It has been argued that using reward as an incentive to change behavior has the potential of redirecting the intention of a particular activity (Colineau and Paris 2011). Similarly, Gneezy and Rustichini (2000) in their study of the effect of small and large rewards on people's motivation, showed that the introduction of monetary compensation did undermine performance, especially if the reward is considered small. This suggests that rewarding may change the way people perceive the targeted behavior and the benefit they attribute to it. This is further confirmed by comments from our participants "*if the rewards were for giftcards and such, it will worth it and may convince me to eat better and exercise*"; "*A lot of this would depend on what the points could be used for, earning points that could be used for online purchases would be really great!*". This shows that the motivation to adopt healthy behavior—for any application that employs reward—for this group of users will depend mostly on the kind and size of reward, what it can used for, thereby trivializing the main purpose of healthy behavior. Therefore, the PT designer should apply some caution when employing any form of reward to motivate health behavior.

However, it is worth noting, that some studies demonstrated positive effects of incentive mechanisms and showed that change in behavior can persist after reinforcement is removed (Cameron and Pierce 1994). Our findings emphasize the need to tailor the rewards based on the user's susceptibility to and perception of reward.

4.3 Results discussion

In this section, we present heuristics that serve as a guideline for deciding on the appropriate strategies to employ in persuasive game design. Specifically, we present the best strategies and the worst strategies for designing persuasive games for each gamer type, and the generally most and least efficacious strategies based on their overall persuasiveness. Next, we present two approaches for applying our model results to persuasive game design, and map strategies to game design mechanics.

4.3.1 Deciding on the strategies to employ for each gamer type

The results summarized in Table 5 show some variability in the perception of various strategies by the gamer types. Some gamer types are positively and significantly associated with many strategies while others are only associated with few. The positive and significant associations suggest that the gamer types are receptive to the strategies and can therefore be motivated to adopt healthy behavior using the strategies. Based on our results, we present the best strategies to influence health behavior change and the worst strategies to avoid when designing for each gamer type in Tables 6 and 7 respectively.

These results suggest the need for persuasive game designers to take special care not only in deciding on which strategies to employ to motivate behavior performance for each gamer type, but also which strategies to avoid in order not to deter users from performing the target behavior. The results from our model can serve as a guide for persuasive game designers to decide on the appropriate strategy to employ for each gamer type. Our results are inline with Kaptein et al. (2012), who found that a one-size-fits-all approach could be detrimental in health promotion applications. Using

Table 6 Best strategy to achieve high persuasive effect for each gamer type—persuasive profile

Gamer type	Best strategy
Gamers with high *Achiever* tendency	'Cooperation', 'Reward', 'Self-monitoring and suggestion'
Gamers with high *Conqueror* tendency	'Competition and comparison', 'Simulation', 'Personalization', 'Self-monitoring and suggestion'
Gamers with high *Daredevil* tendency	'Simulation'
Gamers with high *Mastermind* tendency	'Self-monitoring and suggestion', 'Competition and comparison', 'Personalization', 'Simulation', 'Customization'
Gamers with high *Seeker* tendency	'Customization', 'Personalization', 'Competition and comparison', 'Praise'
Gamers with high *Socializer* tendency	' Cooperation', 'Competition and comparison'
Gamers with high *Survivor* tendency	'Self-monitoring and suggestion', 'Competition and comparison'

Strategies presented in descending order of persuasive strength (underlined is the highest)

Table 7 Worst strategy for motivating health behavior for each gamer type—contra-persuasive profile

Gamer type	Worst strategy
Gamers with high *Achiever* tendency	N/A
Gamers with high *Conqueror* tendency	N/A
Gamers with high *Daredevil* tendency	'Self-monitoring and suggestion', 'Competition and comparison'
Gamers with high *Mastermind* tendency	N/A
Gamers with high *Seeker* tendency	N/A
Gamers with high *Socializer* tendency	'Self-monitoring and suggestion', 'Praise', 'Customization'
Gamers with high *Survivor* tendency	'Cooperation', 'Reward', 'Customization'

Strategies presented in descending order of negative influence

inappropriate strategies for a particular user could lead to an increase in unhealthy behaviour, which the intervention in fact aims to discourage.

4.4 Best general strategies

The results show that some strategies are perceived as persuasive by the majority of our study participants. As can be seen in Table 5, competition and comparison, and self-monitoring and suggestion emerged as persuasive strategies to which most gamer types are receptive. Competition and comparison is significantly and positively associated with all the gamer types except daredevil and achiever. Similarly, self-monitoring and suggestion is associated with four out of the seven gamer types. This implies that employing competition and comparison or self-monitoring and suggestion will likely motivate a positive change in health behavior for the majority of the gamer types while influencing only few gamer types negatively—daredevil and socializer.

Therefore, persuasive game designers who are interested in strategies with an overall good average effect across the gamer types—as opposed to strategies that maximize the persuasive effect on individual gamers—can employ competition and comparison and self-monitoring and suggestion. As shown in Table 5, these strategies are not optimal for each gamer type; however, they present a compromise between the cost of maximizing the effectiveness of the strategies by tailoring them to the gamer types and using a uniform strategy that will be effective for the majority of gamer types. Interestingly, competition and comparison and self-monitoring are some of the most commonly employed strategies in persuasive games for motivating healthy eating and physical activities, based on our analysis of the literature.

It is worth noting that simulation and personalization are not considered among the best general strategies because although they influence none of the gamer types negatively, they are positively associated with only three out of the seven gamer types each.

4.5 Least efficacious strategies

Our results show that some strategies are not capable of producing the desired results of motivating positive behavior change in many users. Based on our results, but perhaps contrary to popular assumption, reward and praise are positively associated with only one gamer type each. Interestingly, they are both also perceived as negative by some gamer types. This implies that manipulating reward or praise in persuasive games that target the general population may in fact not promote behaviour change. Using extrinsic rewards to motivate behavior performance has been debated in literature (Cameron and Pierce 1994; Gneezy and Rustichini 2000), because the rewards can redirect the intention of a particular activity from intrinsic to extrinsically motivated (Colineau and Paris 2011), and might not produce a long-term behavior change. However, almost all persuasive games employ rewards to motivate behavior (Bell et al. 2006; Grimes et al. 2010; Orji et al. 2012; Pollak et al. 2010). Our results showed that reward is not as important as assumed in practical persuasive games, as it can only motivate behavior change for achievers, who have a flair for collecting things in the game (e.g., points). The main reason that the rewards may not work as a persuasive game strategy is that people tend to view the rewards and the values they get from them as the only benefit of adopting a healthy behavior. This implies that persuasive game designers should not use reward and praise as key strategies to influence behavior change. In fact, reward and praise can actually be excluded from persuasive games without significantly decreasing their effectiveness. It is also worth nothing that customization is negatively associated with two gamer types and positively associated with only two gamer types and therefore can be listed among the least efficacious strategies.

5 Mapping game mechanics to persuasive strategies

Based on an analysis of related work on game mechanics (Bjork and Holopainen 2005; http://techcrunch.com/2010/08/25/scvngr-game-mechanics/; http://gamification.org/wiki/Game_Mechanics), we identify a number of ways that strategies can be integrated into games by mapping the eight strategies (competition, comparison, cooperation, customization, personalization, praise, self-monitoring, suggestion, simulation, and praise) to common game design mechanics. We present two approaches for applying our results to persuasive game design—a one-size-fits-all and a personalized approach. We adapted a list of common game mechanics from our previous work (Orji et al. 2013). The list grouped the common game mechanics into seven categories, as shown in Table 8. To bridge the gap between game designers and persuasive game designers, we mapped the strategies to the game mechanics that best matched. For example, for the PT strategy cooperation, we chose *communal discovery* and *viral game mechanics* within the social category in Table 8. Communal discovery is a game mechanic wherein an entire community has to work together (cooperate) to overcome a common challenge or obstacle. Viral game mechanics are game elements that are more enjoyable or only accessible when multiple people play. Table 9 presents the mapping of PT strategy to appropriate game mechanic. The mapping was produced via affinity mapping. Three experts reviewed the definition and applications of various game mechanics and strategies in game design, and together mapped them to the selected candidate game mechanics from Table 8 that could be used in representing the eight strategies.

5.1 "One size fits all" persuasive game design

The results from our models can guide the design of persuasive games using both a one-size-fits-all approach and a personalized approach. We discuss how our findings can be applied to the design of persuasive health games for the broadest audience, to appeal to the majority of players.

Our results show that *simulation* is perceived as positive by conquerors, daredevils, and masterminds and does not negatively impact other gamer types. Therefore, to appeal to a broad group of players, persuasive games *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, behaviour 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 playing the game.

Similarly, *personalization* is perceived as positive by conquerors, masterminds, and seekers and does not negatively impact other gamer types. To appeal to a broad audience, persuasive games *should tailor their contents (using system tailoring as opposed to user customization) to an individual gamer's preference*. Game elements such as cascading information theory, epic meaning, and privacy could be used to create a sense of personalized contents and personal relevance. It is somewhat ironic that personalization appears as a general-purpose strategy, when the goal of personalization is to have systems automatically adapt to specific users or user groups; however, there are ways of deploying personalization as a general strategy. For example, including the participant's name in system messages or considering general colour preferences with respect to cultural or age groups.

Our results also show that the *comparison and competition* strategy has a negative relationship with only one gamer type—daredevil. Assuming an evenly distribution of gamer types, employing competition and comparison in persuasive games design for broad audiences would only have potential negative effects on a small group of players while being beneficial for the majority of users. Therefore, game designers *could employ mechanics that support competition and comparison to appeal to the majority of the population*. For example, game mechanics such as status, envy, countdown, and leaderboard can be used to give players an idea of what and how others are doing, to motivate them to improve and perform better than others in line with the competition and comparison strategy.

5.2 Personalized persuasive game design

Although designing for the broadest possible audience is a common practice, tailoring persuasive experiences to individual users or user groups has been advocated (Berkovsky et al. 2010, 2012; Kaptein et al. 2012). Our results reveal opportunities where personalizing game experience by tailoring strategies for a particular user or user groups is highly desirable. Here, we illustrate with examples how the results from our models can be used for personalizing persuasive games.

For example, consider a designer tasked with building a voluntarily-played Massively Multiplayer Online Role-playing Game (MMORPG) to motivate healthy behavior change. MMORPG games are mostly enjoyed by the achiever and socializer types (BrainHex 2012) and less by the remaining types. Achievers and socializers are both receptive to the cooperation strategy. Because we can assume that a large proportion of MMORPG players will fall into one of these two types, *it is appropriate to use mechanics related to the cooperation strategy when designing persuasive MMORPGs for health behaviour change*. Thus, mechanics such as communal discovery, social fabric of games, viral game mechanics, and companion gaming could be applied to create a sense of community and make the players work together for better health behavior. For example, an MMORPG about healthy eating could involve guilds of players who learn to grow and cook their own produce, and through communal discovery could learn about the nutritional value of different root vegetables (e.g., parsnips versus yams) that transfer into their real-life eating habits.

Consider also masterminds and seekers, who enjoy solving puzzles, devising new strategies, and discovering new things. There are specific types of games that are based on strategic problem solving. Masterminds and seekers are the only gamer types that perceive customization as positive. Therefore, *games tailored for masterminds and seekers, such as puzzle-based games, can effectively use mechanics that suggest customization*. For example, the game mechanics shell games, discovery, and epic meaning could work well with these gamer types because they can be used to create an illusion of choice and control, which customization provides. For example, a narrative-based strategy game related to choosing foods that balance the character's health and satisfaction could give players choices that appear to control the outcome of the story (i.e., shell game).

Finally, consider the socializer, who enjoys playing games with others (Stewart 2011; BrainHex 2012)—there are specific types of games that include vast spaces and levels of detail, that players can take hours to explore. Socializers perceive cooperation as positive, which suggests that *cooperative internet-based play (i.e., social games) would appeal to socializers*. Mechanics such as social fabric of games and viral game mechanics could be used in this context to offer praise. For example, consider a social media-based game (e.g., Farmville) that instead requires players to trade recipes and tips for healthy eating options to make progress in the game.

The last example demonstrates how we can personalize for a particular gamer type by using the results of our model and affinity mapping exercise; personalizing design for a specific gamer type is achieved by following Table 5, which presents a guideline for choosing appropriate strategies for each gamer type and Table 8, which maps the strategies to game mechanics. The first example with the MMORPG shows how persuasive games could be personalized for a particular game genre, by using our results alongside the established links between the kinds of games enjoyed by each gamer type (Stewart 2011; BrainHex 2012). There are many ways in which persuasive games for health could be tailored based on our results, either by using the strategies or the corresponding game mechanics as given in Table 8. We have included three examples here to demonstrate the relationship between our findings and corresponding game mechanics.

5.3 Summary: recommended design steps

We have demonstrated the need to make specific considerations when designing persuasive games to motivate health behavior. Specifically, we have revealed the need to tailor strategies to individual gamer types. We now highlight 3 main steps that could be followed to tailor persuasive games to gamer type with respect to the appropriate strategies.

Step 1: Determine the Gamer Groups

The first step should be to determine the group under consideration. Researchers can either choose a gamer type to target based on knowledge of their intended population (e.g., a group comprised mainly of *achievers*), or by choosing a game genre and then using the BrainHex model (Grimes et al. 2010) to determine the majority classes that enjoy that genre.

Stage 2: Decide on the Design Approach

After identifying the gamer group in step 1, game designers can adopt a personalized approach or a one-size-fits-all approach, depending on whether the targeted gamer groups (step 1) can be positively incentivized using similar strategies—using Table 6.

Step 3: Map strategies to Game Mechanics

The mapping of strategies and game mechanics bridges the gap between the game designers and the PT designers. Game designers can use the mapping to choose appro-

Table 8 Game mechanics organized by category. Not a definitive list, these mechanics are drawn from multiple sources

Category	Mechanic	Explanation
Player	Ownership	Controlling something, "your" property
	Pride	Feeling of joy and ownership after accomplishment
	Envy	Striving for what other players have
	Loyalty	Positive connection with game element leading to ownership
Social	Communal discovery	Community has to work together to overcome obstacle
	Social fabric of games	People grow closer after playing together
	Privacy	Certain information is shared, certain information is kept private
	Viral game mechanics	Game elements which are more enjoyable or only accessible with others
	Companion gaming	Cross-platform gaming
Leaderboards	Achievements	Virtual/physical representation of accomplishment
	Leaderboards	Leaderboards to display highscores
	Status	Rank or level of player
Rewards	Levels	Players receive points for actions, can level up, gain new abilities
	Physical goods	Distribute physical goods to reward players
	Virtual items	Distribute virtual items to reward players
	Reward schedules	Variable and fixed intervals
	Lottery	Give players opportunity of winning stuff
	Free lunch	Give players free gifts
	Points	Measurement of success of in-game actions
	Extinction	Taking reward away
	Disincentives	Punishing player to trigger behavior change
	Loss aversion	Not punishing player as long as desired behavior is shown (but not rewarding either)
	Bonuses	In-game reward for overcoming challenges to reinforce desired behavior, e.g. combos
Behavior	Behavioral contrast	Irrational player behavior
	Blissful productivity	Players work hard within game if actions are meaningful
	Behavioral momentum	Players keep going because they feel what they're doing is valuable
	Urgent optimism	High self-motivation, players want to work on issues instantly with the belief that they will succeed
Game elements	Quests	Tasks that players have to complete
	Endless games	Never ending sandbox play
	Repeat simple actions	Players enjoy repeating simple in-game actions
	Cascading info theory	Gradually introduce players to game
	Appointments	Fixed in-game appointments to make players return at certain times
	Shell game	Illusion of choice to guide player to desired outcome

Table 8 continued

Category	Mechanic	Explanation
	Countdown	Players only get limited amount of time to complete challenge
	Discovery	Giving players opportunity to explore and find new things
Meta	Moral hazard	Actions are devalued by abundance of rewards, too many incentives destroy enjoyment of action
	Epic meaning	Having something great as background story to give meaning to in-game actions

Adapted from Orji et al. (2013)

Table 9 The mapping of PT strategies to common game mechanics

Strategies	Game mechanics	Explanation
Praise	Level	Level as a sign of good job can serve as praise for actions. Players can level up, gain new abilities
	Pride	Feeling of joy and ownership after accomplishment
Cooperation	Communal discovery	Community has to work together to overcome obstacle, individual effort is undermined
	Social fabric of games	People grow closer after playing together; people will play together to make friends
	Viral game mechanics	Game elements that are more enjoyable or only accessible with others will make people want to cooperate
	Companion gaming	Cross-platform gaming can be used to increase the opportunity for many players to play together
Competition and comparison	Status	Rank player to force them to compare and therefore compete
	Envy	Striving for what other players have will increase competition and comparison
	Countdown	Players only get limited amount of time to complete challenge
	Leaderboard	Displaying highscores in leaderboards will introduce competition and comparison
Reward	Physical goods	Distributing physical goods to reward players might lead to increased performance especially if the physical good appeals to players but it might also divert the intention of performing the behavior
	Virtual items	Distributing virtual items to reward players. This may be counterproductive
	Reward schedules	Variable and fixed intervals reward to encourage performance
	Lottery	Give players opportunity of winning stuff
	Free lunch	Give players free gifts
	Points	Measurement of success of in-game actions
	Bonuses	In-game reward for overcoming challenges to reinforce desired behavior, e.g. combos
Simulation	Appointments	Fixed in-game appointments to make players return at certain times
	Leaderboards	Leaderboards to display and project highscores over time

Table 9 continued

Strategies	Game mechanics	Explanation
	Achievements	Virtual/physical representation of accomplishment; achievements can be broken and tied to tasks, it can also be projected
	Status	Rank or level of player to show and project link between behavior and outcome
	Epic meaning	Having something great as background story to give meaning to in-game actions. The story could link behavioral outcomes to player's actions.
	Behavior momentum	Players keep going because they feel what they are doing is valuable. Projecting behavior outcome over a longer period will increase value and reinforce behavior
	Urgent optimism	High self-motivation, players want to work on issues instantly with the belief that they will succeed.
	Blissful productivity	Players work hard within game if actions are meaningful
Personalization	Cascading info. theory	Gradually introducing players to game will create a sense of personal relevance
	Epic meaning	Having something great as background story to give meaning to in-game actions. The story can be tailored to each player using various characteristics e.g., gender.
	Privacy	Certain information is shared, certain information is kept private for the user alone
Customization	Shell game	Illusion of choice to guide player to desired outcome will create a sense of customization
	Discovery	Giving players opportunity to explore and find new things makes players fill sense of control and autonomy associated with customization
	Epic meaning	Having something great as background story to give meaning to in-game actions
Self-monitoring and suggestion	Quest	Displaying tasks that players have to complete help the player monitor performance and progress
	Achievement	Virtual/physical representation of accomplishment enables players monitor progress
	Level	Players receive points for actions to show performance and progress, can level up, gain new abilities
	Loss aversion	Not punishing player as long as desired behavior is shown (but not rewarding either)
	Repeat simple action	Players enjoy repeating simple in-game actions

priate game mechanics (corresponding to the appropriate strategy for each gamer type) that can be used to tailor the persuasive game to the specific gamer type—this is achieved using Table 9. The mapping can also help the PT designer interpret the effectiveness of persuasion with respect to the PT strategy manipulated versus the game mechanics employed. It would also make it possible to imitate successful interventions.

The three steps above summarize the steps that game designers can follow to tailor persuasive games strategies to gamer types, thereby fostering the development of efficacious persuasive games.

6 Conclusions, limitations, and future work

Recent years have witnessed an increasing number of games designed for the purpose of changing human behavior or attitude using various PT strategies, i.e., persuasive games. Several decades of research on persuasion have resulted in a number of strategies that can be employed in developing various persuasive games. However, there has been little research on how to tailor these strategies to achieve a desirable outcome in game players. This has resulted in an increasing adoption of a designed-by-intuition, one-size-fits-all approach to persuasive game design. Our work is the first attempt towards providing practical ways of applying and tailoring strategies in persuasive game design using the players' personalities as described by gamer types. We conducted a cross validation of perceived persuasiveness of various strategies and developed models showing the receptivity of gamer types to various strategies. Our models revealed some differences in receptivity to various strategies between the seven gamer types and we discussed these differences from the perspective of health behavior, gamers' personalities, and persuasive game design. Through our study, we exposed the limitations of the current approaches to persuasive game design, and presented design opportunities for both a one-size-fits-all and a personalized approach to persuasive game design that is grounded in data. Our study highlighted the list of strategies that should be reinforced to increase the persuasive effect of games for each gamer type—the best strategies—and the worst strategies that should be avoided for each gamer type. We highlighted the strategies that could influence the majority of players positively—best strategies—and the ineffective strategies that incentivize few players. We also highlighted the highly persuadable gamer types that are receptive to the most strategies and the low persuadable gamer types that are receptive to only a few strategies. Finally, we suggest a mapping of strategies to common game design mechanics to bridge the gap between PT designers and game designers.

This study is the first to link research on the psychology of player typologies (as identified by BrainHex) with the strategies to find patterns in gamers' motivation that can inform the choice of strategies and game mechanics for designing games that will motivate behavior change. We argue that having a persuasive profile of various strategies that motivate different gamer types provides a crucial methodological bridge between game researchers and persuasive technology researchers and also between personalization researchers and persuasive technology researchers. Our data-driven approach for tailoring persuasive games benefits from the best practices of both game designers, who identified various gamer types, and PT designers, who identified various strategies for motivating behavior change.

There are limitations of applying the results of our model to game design mechanics. First, although we adapted the list of game design mechanics from previous research, the list is by no means exhaustive or definitive. Second, we mapped the strategies to game mechanics using an affinity mapping exercise by three judges. These categories are helpful for bridging the gap between PT designers and game designers; however, the process is subject to interpretation. Third, we apply the results of our models at the level of a population (gamer type). As with all population-based personalization, our results will apply to the majority of the population; however, there may be outliers who do not respond in the predicted manner. Fourth, we make our findings actionable by providing examples of how our model results can be incorporated into persuasive game design. This process is not prescriptive of good game design—although our results can provide an advantage in choosing the best persuasive strategy to apply in a persuasive game, applying our findings may not ensure that a game is engaging or fun to play. Fifth, our study reports the perceived persuasiveness of various strategies, however, the actual persuasiveness of the strategies may differ when implemented in a specific game. Therefore, future research will focus on examining the persuasiveness of the recommended strategies deployed in persuasive games. Sixth, the instantiation of the strategies in the storyboards may have influenced the results, therefore, a study with a real intervention (a game implementing some of these strategies) will be used in the future work to validate the results of this study. Finally, our work inherited some of the limitations of player typologies: the first is partial membership—although membership is in a single type, a player could be, for example, mostly achiever, but also highly mastermind. It is important to note that this is a limitation of all player typologies. As a solution of this problem, with a very large dataset, future research could establish a threshold difference of at least 3 between the maximum type score and the sub types for each participant. Again, although the player topology as developed by BrainHex has been shown to be reliable, it is possible that just like other subjective measures, player typology may have low test-retest reliability.

Our work has benefited from the large-scale study of persuasiveness of the strategies with respect to eating behavior and we can claim applicability in other health behavior domains (due to the high level nature of the storyboard depicting the strategies). However, our model should be applied with caution to other health behavior domains (such as, for example, encouraging physical activity or discouraging smoking). While the underlying principle of mapping strategies to game mechanics and tailoring to gamer types can be applied in any health behavior domain, and gamer type has been proven as a reliable characteristic for tailoring persuasive game interventions, other characteristics, such as sex, age, and culture (not considered in our study) might moderate the impact of the strategies studied in this work.

This paper describes a first attempt towards tailoring strategies to gamer types and also mapping strategies to game mechanics to bridge the gap between game researchers and research on designing persuasive technologies for health. Although this study showed many interesting and significant findings, it also opens up many areas for further examination. In the future, we will investigate combinations of gamer types (e.g., whether there exist some variabilities in the perception of strategies for people who are mostly achiever but also highly conqueror). Our results should be validated in other health behavior domains (e.g., physical activity, smoking cessation) to investigate possible, although unlikely, changes in gamers' receptivity to various persuasive strategies. Our results highlighted differences in the receptivity of the seven gamer types to the ten PT strategies. This suggests a need for a comprehensive list of persuasive profiles—comprised of PT strategies that could motivate various gamer types to adopt healthy behavior. Future studies should therefore examine how the seven gamer types perceive various PT strategies. It would also be interesting for future research to examine the relationships between the persuasive strategies and various gamer sub types, e.g., seeker-mastermind, achiever-conqueror. Finally, we aim to apply our findings to persuasive game design and evaluate whether a game design that is tailored to the individual gamer type following our model and generated guidelines will be effective at motivating behavior change.

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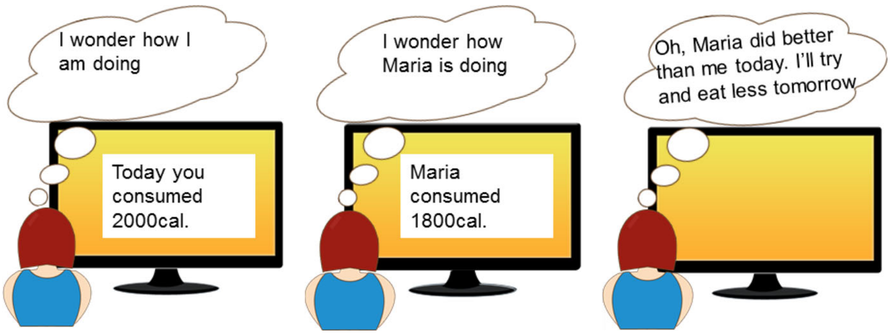
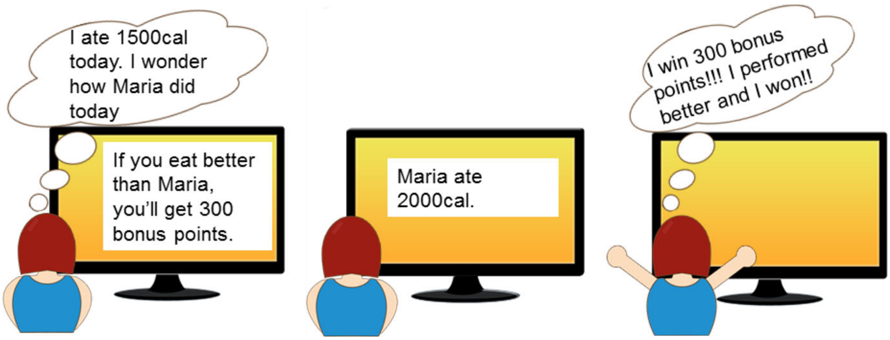
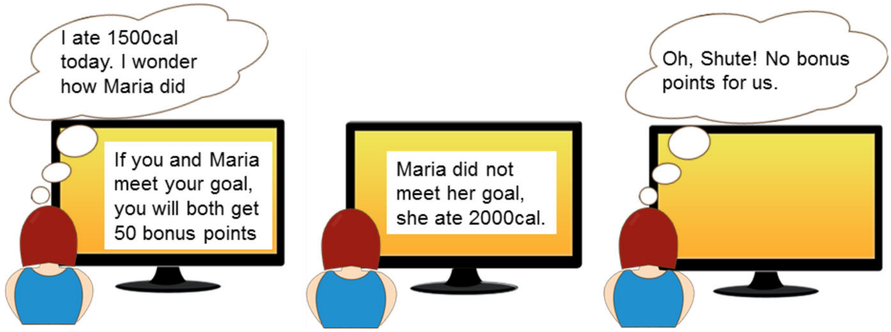
Appendix



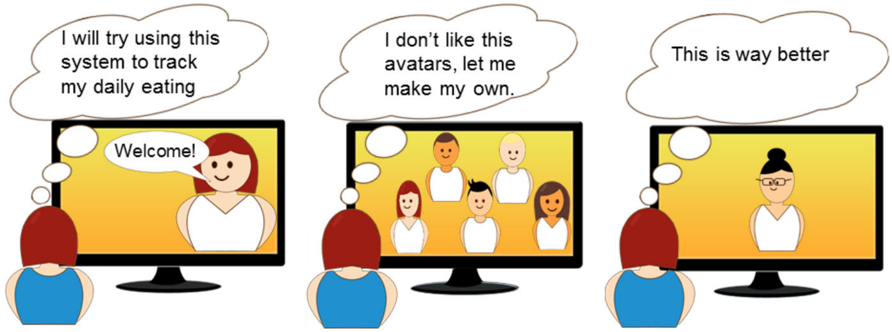
Storyboard Illustrating Comparison Strategy



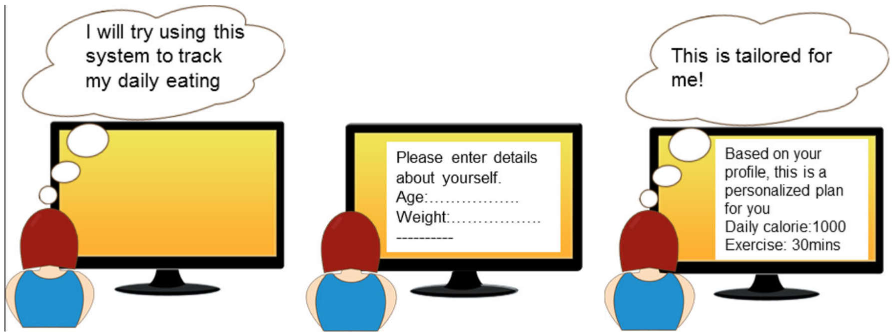
Storyboard Illustrating Competition Strategy



Storyboard Illustrating Cooperation Strategy



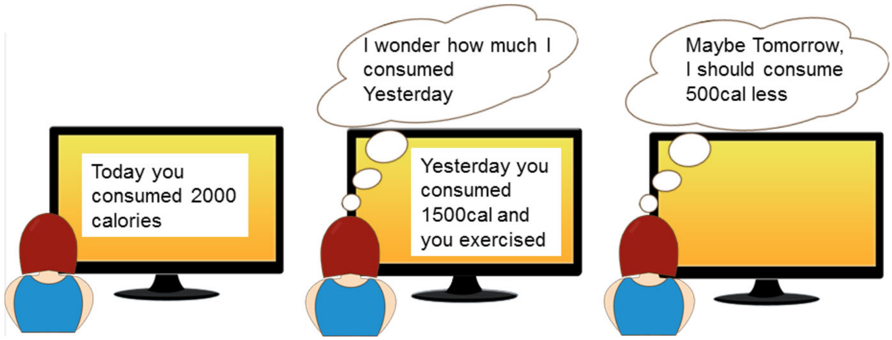
Storyboard Illustrating Customization Strategy



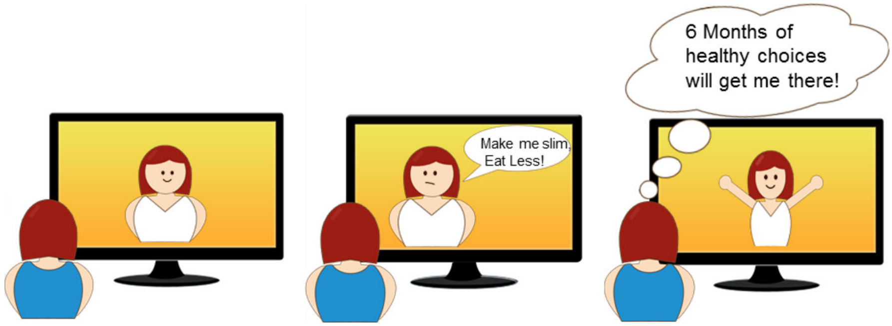
Storyboard Illustrating Personalization Strategy

Storyboard Illustrating Praise Strategy

Storyboard Illustrating Reward Strategy



Storyboard Illustrating Self-monitoring Strategy



Storyboard Illustrating Simulation Strategy

Storyboard Illustrating Suggestion Strategy

Each storyboard was followed by two comprehension questions (1) and (2) and questions for accessing perceived persuasiveness of the strategies (3):

1. In your own words, please describe what is happening in this storyboard …
2. What strategy does this storyboard represent?—Participants were required to choose one out of the ten strategies.
   a. CUSTOMIZATION—(An application that allows user to customize its content (e.g., the appearance of avatar) to his/her choice).
   b. SIMULATION—(An application that provides the means for a user to observe immediate and projected outcome of his/her behavior).
   c. SELF-MONITORING and FEEDBACK—(An application that allows user to track his/her own performance or status. It provides information on both past and current performance).
   d. PRAISE—(An application that applauds its users for performing target behaviors via words, images, symbols, or sounds as a way of giving positive feedback to the user).
   e. SUGGESTION—(An application that recommends certain behaviors (for achieving a favorable/desired outcome) to its use).
   f. REWARD—An application that offers virtual rewards to users in order to give credit for performing the target behavior.
   g. COMPETITION—(An application that provides means for users to compete with others. It awards points (as virtual reward) to winner).

   h. COMPARISON—(An application that provides means for a users to view and compare his/her performance with the performance of other user(s)).
   i. COOPERATION—(An application that provides users opportunity to cooperate (work together) to achieve shared objectives. Users are rewarded if they achieve their collective goals).
   j. PERSONALIZATION—(An application that offers personalized content and services to its users. Recommendations are based on users' personal characteristics).

3. Scales for accessing perceived persuasiveness of the strategies.
   Imagine that you are using the system presented in storyboard above to track your daily eating, on a scale of 1 to 7 (1-Strongly disagree and 7-Strongly agree), to what extend do you agree with the following statements:

   a. The system would influence me.
   b. The system would be convincing.
   c. The system would be personally relevant for me.
   d. The system would make me reconsider my eating habits.

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Regan L. Mandryk is an Associate Professor of Computer Science at the University of Saskatchewan. She pioneered the area of physiological evaluation for computer games in her award-winning Ph.D. research, conducted at Simon Fraser University with support from Electronic Arts. In her current research she continues to investigate affective game evaluation, but also develops and evaluates persuasive games to encourage healthy behaviours, exergames, games for special populations including children with neurodevelopmental disorders, and ubiquitous games that merge the real world with the game world.