Design For Behaviour Change: A Model-Driven Approach For Tailoring Persuasive Technologies

A Thesis Submitted to the
College of Graduate Studies and Research
in Partial Fulfillment of the Requirements
for the Degree of Doctor of Philosophy
in the Department of Computer Science
University of Saskatchewan
Saskatoon

By

Rita O. Orji

Permission to Use

In presenting this thesis in partial fulfilment of the requirements for a Postgraduate degree from the University of Saskatchewan, I agree that the Libraries of this University may make it freely available for inspection. I further agree that permission for copying of this thesis in any manner, in whole or in part, for scholarly purposes may be granted by the professor or professors who supervised my thesis work or, in their absence, by the Head of the Department or the Dean of the College in which my thesis work was done. It is understood that any copying or publication or use of this thesis or parts thereof for financial gain shall not be allowed without my written permission. It is also understood that due recognition shall be given to me and to the University of Saskatchewan in any scholarly use which may be made of any material in my thesis.

Requests for permission to copy or to make other use of material in this thesis in whole or part should be addressed to:

Head of the Department of Computer Science
176 Thorvaldson Building
110 Science Place
University of Saskatchewan
Saskatoon, Saskatchewan
Canada
S7N 5C9

Abstract

People generally want to engage in a healthy lifestyle, to live in harmony with the environment, to contribute to social causes, and to avoid behaviours that are harmful for themselves and others. However, people often find it difficult to motivate themselves to engage in these beneficial behaviours. Even adopting a healthy lifestyle, such as healthy eating, physical activity, or smoking cessation, is hard despite being aware of the benefits. The increasing adoption and integration of technologies into our daily lives present unique opportunities to assist individuals to adopt healthy behaviours using technology. As a result, research on how to use technology to motivate health behaviour change has attracted the attention of both researchers and health practitioners. Technology designed for the purpose of bringing about desirable behaviour and attitude changes is referred to as *Persuasive Technology* (PT). Over the past decade, several PTs have been developed to motivate healthy behaviour, including helping people with addictive behaviour such as substance abuse, assisting individuals to achieve personal wellness, helping people manage diseases, and engaging people in preventive behaviours. Most of these PTs take a one-size-fits-all design approach. However, people differ in their motivation and beliefs about health and what constitutes a healthy life. A technology that motivates one type of person to change her behaviour may actually deter behaviour change for another type of person. As a result, existing PTs that are based on the one-size-fits-all approach may not be effective for promoting healthy behaviour change for most people.

Because of the motivational pull that games offer, many PTs deliver their intervention in the form of games. This type of game-based PTs are referred to as *persuasive games.* Considering the increasing interest in delivering PT as a game, this dissertation uses persuasive games as a case study to illustrate the danger of applying the one-size-fits-all approach, the value and importance of tailoring PT, and to propose an approach for tailoring PTs to increase their efficacy.

To address the problem that most existing PTs employ the one-size-fits-all design approach, I developed the Model-driven Persuasive Technology (MPT) design approach for tailoring PTs to various user types. The MPT is based on studying and modelling user's behaviour with respect to their motivations. I developed the MPT approach in two preliminary studies (N = 221, N = 554) that model the determinants of healthy eating for people from different cultures, of different ages,

and of both genders. I then applied the MPT approach in two large-scale studies to develop models for tailoring persuasive games to various gamer types. In the first study (N = 642), I examine eating behaviours and associated determinants, using the Health Belief Model. Using data from the study, I modelled the determinants of healthy eating behaviour for various gamer types. In the second study (N = 1108), I examined the persuasiveness of PT design strategies and developed models for tailoring the strategies to various gamer types. Behavioural determinants and PT design strategies are the two fundamental building blocks that drive PT interventions. The models revealed that some strategies were more effective for particular gamer types, thus, providing guidelines for tailoring persuasive games to various gamer types.

To show the feasibility of the MPT design approach, I applied the model to design and develop two versions of a Model-driven Persuasive Game (MPG) targeting two distinct gamer types. To demonstrate the importance of tailoring persuasive games using the MPG approach, I conducted a large-scale evaluation (N = 802) of the two versions of the game and compared the efficacy of the tailored, contra-tailored, and the one-size-fits-all persuasive games condition with respect to their ability to promote positive changes in attitude, self-efficacy, and intention. To also demonstrate that the tailored MPG games inspire better play experience than the one-size-fits-all and the contra-tailored persuasive games, I measure the gamers' perceived enjoyment and competence under the different game conditions.

The results of the evaluation showed that while PTs can be effective for promoting healthy behaviour in terms of attitude, self-efficacy, and intention, the effectiveness of persuasion depends on using the right choice of persuasive strategy for each gamer type. The results showed that one size **does not** fit all and answered my overarching research question of *whether there is a value in tailoring PT to an individual or group.* The answer is that persuasive health interventions are more effective if they are tailored to the user types under consideration and that not tailoring PTs could be detrimental to behaviour change.

Acknowledgements

There are so many people than I can possibly name to thank for helping me through this journey. However, special thanks need to go out to people who have tremendously impacted me and my work.

First, I would like to express my genuine thanks to my supervisors, Dr. Julita Vassileva and Dr. Regan Mandryk for their guidance, constructive criticisms, suggestions, and support. I learned a lot from you. Thank you for your patience, corrections, and encouragement!

My thanks also go to my committee for their many questions and suggestions:

Dr. Judith Masthoff, Department of Computer Science, University of Aberdeen (External Examiner).

Dr. Kent Kowalski, Department of Kinesiology, University of Saskatchewan (Cognate).

Dr. Dwight Makaroff, Department of Computer Science, University of Saskatchewan (Chair).

Dr. Carl Gutwin, Department of Computer Science, University of Saskatchewan.

Dr. Kevin Stanley, Department of Computer Science, University of Saskatchewan.

Dr. Nathaniel Osgood, Department of Computer Science, University of Saskatchewan.

I am also thankful to my fellow graduate students from both the HCI and MADMUC labs, especially Kathrin Gerling, Richard Lomotey, Johnson Iyilade, Bunmi Adewoyin, and Edgar Lelei for their friendship and assistance with my studies.

Thank you to my professors and mentors Dr. Virginia Ejiofor, Dr. Ebele Osita, Dr. Yasemin Yardimci, Dr. Jude Uzonna, Dr. Patience Elabor-Idemudia, Dr. Nduka Otionu, Dr. Temitope Oriola, Dr. Ifeanyi Ezeonu, Dr. Ikechukwu Ogucha, and Sen. Ike Ekweremadu. Thank you for influencing my life positively. You were like shining lights, strategically positioned to illuminate my path and be a source of inspiration, especially in moments of doubt and despair.

I am also deeply thankful to Dr. John Okoye, Rev. Fr. Patrick Ampani, Rev. Fr. Bartholomew Aniebo, Rev. Fr. Thomas Edogbanya, Rev. Fr. Jude Onebunne, Rev. Fr. Emmanuel Mbah, Uchenna Anagbogu, Engr. Chidimma Okeke, Ig Onuorah, Joseph Obi, John Okoye, and Engr. Raymond

Okenwa for persistently knocking on heaven's door on my behalf and supporting me through thick and thin. Heaven heard your voice!

My heartfelt thanks go to the entire Orji's family for the unconditional love, sacrifices, unending prayers, and encouragement through one of the most challenging things I have done. I am deeply indebted to you Nkechi, Henry, Fidel, Amaka, Jane, Abel, Moses, Robinson, Kezie, Juju, Junior, and Uncle Sylvester. Thank you for being an astoundingly supportive family. Your trust and confidence in me encouraged me to try things that even when I did not believe I could do. You are my pillar!

My Father and Mother – Okonkwo Raphael Orji and Maria Orji – you are both dead now, but I thank you for planting good seeds in me. You dreamt of this day but never lived to see it come true, but I know you did not leave me. I felt your presence throughout the journey as a source of strength that kept me going. Thank you!

I am most grateful to God almighty for making everything possible – for giving me the opportunity to make a contribution to a research area about which I am so passionate, for directing my path, especially in the choice of graduate school and supervisors to work with, and for giving me the strength I needed to complete my Ph.D process. Thank you God!

Finally, I would like to thank the Canadian Government NSERC, Vanier, University of Saskatchewan, and Nigerian Government for their generous financial support.

Dedicated:

To God Almighty, for His unconditional love and unmerited favours to me,

In loving memory of my parents late Chief Okonkwo Raphael Orji and Maria Orji, thank you for your sacrifices, you allowed me an opportunity that you never had. I will forever remember you!

CONTENTS

LIST OF FIGURES

LIST OF TABLES

LIST OF ABBREVIATIONS AND DEFINITIONS

PT	Persuasive Technology
MPT	Model-driven Persuasive Technology
MPG	Model-driven Persuasive Game
HBM	Health Belief Model
PSD	Persuasive System Design
CFA	Confirmatory Factor Analysis
EFA	Exploratory Factor Analysis
PLS-SEM	Partial Least Square Structural Equation Modeling
SUS	Percieved Susceptibility
SEV	Percieved Severity
BAR	Percieved Barrier
BEN	Percieved Benefit
CUA	Cue to Action
EFF	Self-efficacy
MBTI	Myers-Briggs Type Indicator
FFM	Five Factor Model
MMORPG	Massively Multiplayer Online Role-playing Game
IMI	Intrinsic Motivation Inventory
AMT	Amazon Mechanical Turk
JunkFood ALIENS-C	Competition-based JunkFood ALIENS
JunkFood ALIENS-R	Reward-based JunkFood ALIENS
RM-ANOVA	Repeated Measure Analysis of Variance
Behaviour Determinants	Factor that influence behaviour
Persuasive Technology	Technology that are intentionally designed to change human behaviour or attitutde
Persuasive Game	Game-based Persuasive Technology
Gamer Types	Game players' personality types
Persuasive Strategies	Techniques used in PT design to motivate change in behaviours

CHAPTER 1

INTRODUCTION

People generally want to engage in a healthy lifestyle, to live in harmony with the environment, to contribute to social causes, and to avoid behaviours that are harmful for themselves and others. However, people often find it difficult to motivate themselves to engage in these beneficial behaviours. Even adopting a healthy lifestyle, such as healthy eating, physical activity, or smoking cessation, is hard despite being aware of the benefits.

The increasing adoption and integration of technologies into our daily lives present unique opportunities to assist individuals to adopt healthy behaviours using technology. As a result, research on how to use technology to motivate behaviour change have attracted the attention of both researchers and health practitioners. Research has shown the potential of technology to motivate healthy behaviour – help people with addictive behaviour such as substance abuse [116], assist individuals to achieve personal wellness, manage diseases, and engage in preventive behaviours [44,77,100,143]. These type of technologies have been referred to as *persuasive technology* by Fogg [62].

Persuasive Technology (PT) is a term used in describing interactive applications that are designed for the primary purpose of bringing about desirable changes by shaping and reinforcing behaviour, attitude, and thoughts about an issue, action, or object without using deception or coercion [25,62]. PT has proven effective at stimulating behaviour change in various domains. For example, researchers have developed systems to help people stop smoking [53,112], lower the amount of energy they consume [14], increase their physical activity [24], manage chronic diseases [31,127] and eat healthily [145]. Among all these domains of application of PT, applications for promoting healthy eating behaviour have attracted special attention [77,145,180]. The design of such applications is an area of concern of health and wellness researchers; many of whom have suggested that most of the chronic diseases and health conditions that burden the health care system (e.g., obesity, type 2 diabetes) can be prevented through adequate changes in eating behaviour [70,76,77,103,145]. Unhealthy eating is a major factor contributing to the onset of several diseases and health conditions [130,142]. Research has shown that good eating habits can prevent, or at least reduce, the risk of obesity, heart disease, and type II diabetes [192]; therefore, behaviour interventions aimed at modifying eating behaviour are seen as important for the prevention and treatment of these conditions [121]. Despite the increasing interest in this area, there remains a need for research into the various approaches to designing PT for motivating healthy eating behaviour [74]. Therefore, this research will use healthy eating as a case study to investigate how to design PT interventions for motivating healthy behaviour.

1.1 Problem

The problem to be addressed in this dissertation is: *most existing persuasive technologies take a one-size-fits-all design approach*, *rather than tailoring their persuasive approaches to various users and user groups.* Despite the growing interest in using PT to motivate healthy behaviour and the established differences between individuals and groups of individuals [16,19,81,196], most existing PTs treat users as a monolithic group by adopting a one-size-fits-all design approach. Although a few PTs have been designed with a specific user or cultural group in mind (e.g., [77,112]), the influence of various user personalities – as identified by various researchers (e.g., BrainHex [19]) – on the efficacy of PTs and the choice of persuasive strategy to motivate health behaviour change has largely been ignored. However, decades of research on individual differences and technology users' motivation has shown that treating people as a monolithic group is a poor design approach [16,19,73,104,196] – as what works for one individual may actually demotivate behaviour change in another [143]. Following from this, various models have been developed that could be used for classifying PT users into various personality types (based on their motivations) [16,17,19,73]. Therefore, members of one personality type may respond differently to various PT interventions and PT may be more effective when they are tailored to various users' personalities under consideration.

There are two main reasons why an increasing number of PT designers adopt the one-size-fits-all approach: First, there is no guideline on how to tailor PTs to various users' personalities. Although, some useful frameworks and approaches for developing PT interventions [63,139] have been developed, they provide little information or insight on how PTs can be tailored to various users and user groups. Other researchers have acknowledged the need for tailoring PTs. For instance, Kaptein et al. [100] identified a need to adapt the means to persuasion by adapting the various influence strategies. Arteaga et al. [11] identified the need for present persuasive system design techniques to be adapted to account for variations in users' personalities identified by the Five Factor Model (FFM) of personality traits [73]. Similarly, Halko and Kientz [81] confirmed that certain persuasive strategies are preferred more by users associated with particular personalities, as identified by the FFM.

Second, most PTs in existence to date assume the one-size-fits-all approach because personalization is a complex task that requires a multitude of expertise in various domains, including psychology and human behaviour, user experience study and analysis, PT design, evaluation, and interpretation of results with respect to the underlying behaviour. For instance, it requires some level of expertise in multiple domains to study people's health behaviour with respect to what motivates them, develop rich models of behavioural determinants – factors that motivate or hinder behaviour performance, translate models into PT design artefacts, design and develop PTs that are driven by the models, evaluate the PTs, and interpret the results with respect to the underlying persuasive and behaviour change components. These multitude of expertise are not usually readily available for many PT design projects, and it is hard to find these broad areas of expertise in a single individual – many PT designers do not have the background to effectively develop, interpret, and apply theories and models in their design. Therefore, modeling and developing persuasive profiles (comprising a list of suitable persuasive approaches) for tailoring persuasive games to various gamer types can close this gap by translating the psychology of health behaviour to familiar and actionable PT design approaches.

Thus, the following overarching question has guided my dissertation work: *how can PTs be tailored to various user types to increase their efficacy at motivating health behaviour change and is there value in tailoring PTs for health?*

1.2 Motivation

Research has shown that treating users a monolithic group in persuasive system design is a poor design approach [81,102,111] and therefore has pointed to the limitations and risks of the *one-size-fits-all* approach to persuasive intervention design, especially those aimed at motivating health behaviour, which include:

1. The risk of demotivating health behaviour which the PT interventions intend to promote [103,163] by using inappropriate persuasive approaches.
2. Mixed findings and unexpected failure of PTs to achieve their intended objective of promoting behaviour [70,103,133,163] as a result of employing ineffective persuasive strategies.
3. Overly complex persuasive interventions (due to use of multiple persuasive strategies), which overwhelms the users and lead to cognitive overload [110].
4. Difficulty evaluating what persuasive approaches worked and why they worked [71,143].
5. Due to lack of guidelines, there is increased adoption of the design-by-intuition one-size-fits-all approach [84,143].

The risk of demotivating health behaviour: Persuasive strategies are techniques that can be employed in PT to motivate behaviour and/or attitude change. Several researchers have pointed to the danger of the *one-size-fits-all* approach to persuasive intervention design due to the high tendency of using inappropriate persuasive strategies, which could be counterproductive. For example, Kaptein et al. [45], 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 behaviour 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 persuasive strategies that can be counterproductive or backfire [103]. Similarly, Segerstahl et al. [163] in their study of the pitfalls of persuasive technology discovered that several persuasive strategies in use today evoke negative user experience (that discourages behaviour) due to lack of tailoring of the persuasive strategies to the users. They therefore concluded that persuasive approaches and strategies need to be tailored to achieve their intended objective of motivating behaviour change – "*functional principles often need facilitative principles, such as tailoring to work appropriately. Facilitating principles define, how a functional principle can be applied.* [163]"

To further illustrate this, consider a PT designer who aims at motivating a person called Jane (who is moderately active) to increase her physical activity by increasing her daily step counts. The designer uses a persuasive system that uses accelerometer to track Jane's step count and compares it with that of Jane's friends. The system provides Jane with feedback highlighting the winner in the competition based on the total daily step count. Because Jane is competition averse and dislikes to be compared with her friends, she stops walking out and exercising entirely, and her total physical activity is reduced. Jane moves from moderately active to sedentary. As a result, the system which was intended to promote physical activities has ended up decreasing it, because of the designer's failure to study Jane's behaviour and develop models of Jane's motivation to know that Jane is demotivated by competition and comparison. This example illustrates one of the dangers of employing the one-size-fits-all approach to PT intervention design; however, the risk could be more critical for some other health interventions.

Mixed findings and unexpected failure of PTs: The advancement of PT as a field is hindered by inconsistencies in the results of evaluations of PT with respect to their efficacy to motivate behaviour change in different user groups. Despite numerous studies that have demonstrated the effectiveness of various PTs in motivating behaviour change, there are also accounts of unexpected failures and negative reactions (see [70,103,133,163]). For example, Halko and Kientz, in their exploratory study of health promoting mobile applications that implement various persuasive approaches, discovered mixed results with respect to the relationship between the persuasive approaches and behaviour change of various users, depending on the user's personality type [81]. The effectiveness of specific persuasive strategies implemented in applications for promoting behaviour change varies for various personality types. Similarly, we investigated [143] the influence of behaviour determinants and persuasive strategies on various gamer types, and discovered that certain determinants of healthy behaviour (e.g., perceived severity, cue to action) and strategies are incapable of producing the desired behaviour change [143]. In addition, in the evaluation of a popular persuasive mobile-health game application called *National Mindless Eating Challenge* (NMEC) [97], the researchers recorded high attrition rates and identified personally unsuitable tips and strategies as the major barrier that prevented some people from making changes while using the PT. Finally, Segerstahl et al. [163] described the failure of a web-based persuasive system to achieve the intended objective of motivating weight loss due to the use of personally unsuitable persuasive approaches. For a detailed review of unsuccessful PTs, see [154].

Overly complex persuasive game intervention: Because decisions on persuasive strategies to employ in PT designs are often based on intuition – guess work – it is a common practice for PT designers to incorporate multiple strategies in a single persuasive game. This is done with the hope that at least one of the strategies will be suitable for motivating behaviour change in the target audience or appeal to different type of persons, as may be present in a one-size-fits all approach. According to Harjumaa et al. [83], persuasive strategies are often applied in combinations when incorporated as actual software functionalities. The direct result of this is an overly complex persuasive system that may overwhelm the users, lead to cognitive overload, and inspires negative experience from using the system [163]. This is supported by the finding by Khaled et al. [110] that having too many features in a persuasive game overwhelmed participants and led to cognitive overload.

Difficult to evaluate what persuasive approach worked and why they worked: As a result of employing multiple persuasive approaches in PTs design, it is difficult to evaluate what persuasive approaches worked and why they worked. This makes it difficult for designer of persuasive games to apply research findings from successful PT interventions in their own PT design that may be targeting a different behaviour and/or audience, thereby slowing the advancement of the PT and behaviour change system design as a field.

Due to lack of guidelines, there is increased adoption of the design-by-intuition one-size-fits all approach: Lack of readily available guidelines for tailoring PT to various users and user groups coupled with the multiple expertise required to develop tailored PTs lead to an increasing adoption of the design-by-intuition one-size-fits-all approach. Developing tailored PTs would require rich knowledge of various users types and the target behaviour. PT designers may not have the resources (time, money, and knowledge) needed to study, understand, and develop guidelines for tailoring PT before actual PT design.

1.3 Persuasive Games

PT designers use several approaches to deliver their interventions to effect desired behaviour change in the end user – the preferred approaches being those that are natural or common among the target users. For example, playing computer games is a very common activity among young people. The last decade has witnessed a significant increase in the use of computer games in our daily lives.

According to the most recent report by the US Entertainment Software Association (ESA) in 2013, no other sector has experienced explosive growth like the game industry; nearly every device with a screen is used these days for playing games [58,59]. Specifically, an average American household owns at least one dedicated game console and 58% of the American population play video games, with an average game player age of 30 and very similar percentages of male and female players (55% and 45%, respectively). As a result, delivering PT in the form of a game has become a common practice. These types of games are referred to as *persuasive games*. Persuasive games are interventions with the primary purpose of changing a user's behaviour or attitude [62] using various behavioural determinants and PT strategies. Persuasive games have attracted the attention of researchers and practitioners as a novel approach for promoting healthy behaviour change because of their motivational pull [156]. In the last decade, several persuasive games targeted at modifying users' behaviours have been developed [14,24,110,145]. For example, *OrderUP!* is a persuasive game that motivates healthy eating by having players play the role of a server in a neighborhood restaurant [77]. Similarly, *Escape from Diab* is a persuasive game on healthy eating and exercise with the main goal of preventing kids from becoming obese and developing diabetes and other related illnesses [181]. *Smoke?* is a smoking cessation persuasive game aimed at motivating players to develop negative attitudes and beliefs about smoking [110].

Despite the growing interest in using persuasive games as tools for promoting healthy behaviour, little attention has been paid regarding how to design persuasive games to increase their efficacy at achieving their intended objective of motivating behaviour change. Research has argued that tailoring PTs can increase their effectiveness at motivating behaviour change [103,112]. As a result, there is an increasing demand for persuasive games, especially those targeting health behaviour to be tailored to suit the target users [23,77,112]. However, most existing persuasive games to date adopt the one-size-fits-all approach in their design. The games are designed based on the assumption that people are motivated to change their behaviour by the same factors, and as a result, they treat people as a monolithic group in their design approach. However, this approach may not be suitable for motivating behaviour change in most users and may actually deter some users from adopting healthy behaviour.

The need to tailor persuasive game interventions is even more pronounced in the health domain, where people have subjective opinions about health and what constitutes a healthy life. People also differ in their attributions of the causes and cures for diseases [187]. Therefore, without the knowledge of user's perceptions and receptivity to various persuasive approaches used in motivating healthy behaviour, persuasive game interventions may just be another tool that may not be useful, not accepted, or have no positive impact for the target audience. In fact, without this knowledge, persuasive games aimed at promoting healthy behaviour may end up being detrimental to the users by demotivating behaviour.

Considering the increasing interest in delivering PT as a game, this dissertation focuses on persuasive games and how they can be designed to increase their effectiveness at motivating healthy (eating) behaviour. Specifically, persuasive games are used as a case study to investigate the danger of applying the one-size-fits-all approach, the value and importance of tailoring PT – adapting them to the specific motivational needs of different types of users – and approaches that can be used to tailor PT for motivating healthy behaviour. One way that persuasive games can be tailored is to adapt the persuasive strategies employed in the game design to various gamer types [100]. Another way is to adapt the theoretical determinants of the target behaviour to the gamer types [138]. Behavioural determinants and persuasive strategies are the two fundamental building blocks that drive persuasive interventions. Although attempts have been made towards tailoring persuasive games, game player models have largely been ignored as a dimension for distinguishing different types of game players. 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 [19]. Hence, there is a need for research on ways of tailoring persuasive game interventions to various gamer types by adapting the persuasive strategies and behavioural determinants employed. Kaptein and Eckle [101] describe this type of adaptation of 'ways' of achieving intended persuasion objectives as *means-based* adaptation and it is different from *end-based* adaptation where the end goal of a PT is personalized to the users or user group. The mean-based adaptation has been advocated by researchers. According to Berkovsky et al. [25], tailoring persuasive strategies has a *"huge untapped potential to maximize the impact of persuasive applications"*; however, research into the various ways of tailoring persuasive strategies is only starting.

Thus, the specific question to be answered in my dissertation work is: *how can persuasive games be tailored to various gamer types to increase their efficacy at motivating health behaviour change and is there value in tailoring persuasive games for health?*

1.4 Solution

To answer the research question, this dissertation proposes an approach for tailoring PTs. Specifically, I present the idea of a Model-driven Persuasive Technology (MPT) design approach for tailoring PTs to various user types. The MPT is based on first studying the target audience (with respect to the behaviour of interest and motivation) and developing models for tailoring PTs to various user types using the data from the user study.

In general, the model-driven approach comprises four major stages (see Figure 1.1): (1) a user study and behaviour data collection stage, (2) a modeling stage, (3) a mapping of behaviour determinants and persuasive strategies (as may be desired) stage, and (4) an MPT design stage.

1. The first stage in developing a MPT is to study the target audience with respect to the target behaviour, behavioural determinants (determinants for brevity), their perception of various persuasive strategies (strategies for brevity), and their characteristic user type. The user study stage empirically gathers data from the users that allows some classification and characterization of users based their types, perception of various persuasive strategies, and the influence of various determinants on their behaviour. Several user personality models exist that could assist in understanding various user types (e.g., the BrainHex gamer type model [19] and the FFM [73]). Other known distinguishing user characteristics such as gender and age can also assist in understanding the various user types that may lead to PTs with different effectiveness. The literature can provide hints on determinants and strategies that could be used as baselines for the user study; however, the user study may reveal some other important determinants and strategies that have not been identified in the literature. Therefore, the result from the user study may be used to update the literature, as shown by the bi-directional arrows in Figure 1.1.

2. The second stage, which is the modeling stage, utilizes the data from stage 1 to develop models showing the relationship between the persuasive strategies or determinants and each type of user with respect to the behaviour of interest. The resulting models are used in tailoring persuasive games. The details of the modeling process are presented in Chapter 3.

3. Because the determinants and most of the strategies are abstract and may not be easy to directly implement as a component in PT design, stage 3 involves mapping the determinants and persuasive strategies to common design components that are actionable in PT design. This stage provides a crucial methodological bridge between research on what motivates behaviour change (i.e., behaviour theories) and research on designing technology to motivate behaviour change. The mapping also makes the results from the models usable by PT designers who may not have the necessary background needed to handle the intricacies involved in studying, modeling and analysis, interpreting, and translating determinants into design components.

4. The fourth and final stage involves applying the results from the models in designing and developing PT (i.e., MPT) that is tailored to the user types identified in stage 1. This stage basically involves selecting appropriate determinants and strategies for each user type from the models in stage 2 and determining the appropriate design techniques using the determinants/strategy and design technique mapping in stage 3.

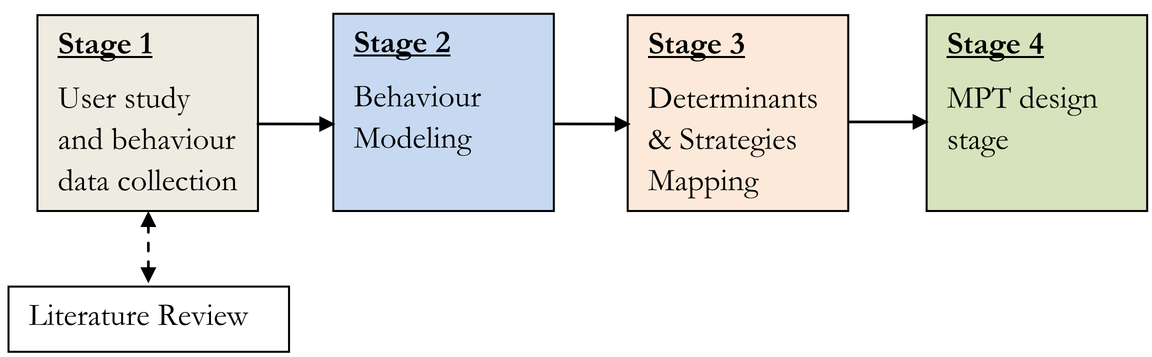


Figure 1.1: The four Stages involved in Model-driven Persuasive Technology Design Approach

Adopting my proposed MPT design approach to persuasive game design gave rise to the Model-driven Persuasive Game (MPG) design approach for tailoring persuasive games to various gamer types.

1.5 Steps in the Solution

Below, I summarize the five major steps that I carried out to develop the model-driven approach to persuasive game design (i.e., MPG) presented in this dissertation.

1. **The Idea of MPT Design Approach:** I developed the MPT approach through two preliminary large-scale studies (N=221, N=554) that investigated and model the determinants of healthy eating for people from different cultures, of different ages, and of both genders.
   In the first study, I investigated 221 participants' fast food eating behaviours and the determinants influencing them. Following from this, I examined for possible variations in the determinants influencing healthy eating attitude for males and females, and developed two separate models for tailoring PT to males and females. The model shows that males and females differ significantly with respect to the determinants influencing their fast food eating behaviour. In the second study, I examined for possible cultural effects on the determinants influencing general eating behaviour (of 554 participants) using the Health Belief Model (HBM) [158]. Based on observed differences in the influence of the determinants (from HBM) on eating behaviour of various user groups depending on their cultural background, I developed ten different models for tailoring PT to various cultural subgroups – Chapter 2. The results from the preliminary studies show that people differ in motivation and gave rise to the concept of the MPT design approach for tailoring PTs.

2. **Identification of Behavioural Determinants and Persuasive Strategies**: In the remaining steps, I determine whether the MPT design approach (developed in step 1) is a feasible approach for tailoring persuasive games – which is the core of my dissertation. As a result, I started the process of developing the Model-driven Persuasive Game (MPG) design approach with a comprehensive review of behaviour change and persuasive technology literature with the aim of identifying various theories, associated determinants, and persuasive strategies that could be applied in developing technologies for promoting behaviour change. This resulted in the identification and classification of various persuasive health games and the deconstruction of various theories and strategies employed in the game design – Chapters 2, 3, 4.

3. **Model-driven Approach Applicability (Study One):** To examine the applicability of my proposed model-driven approach for tailoring persuasive games for health, I conducted a large-scale study of 642 game players' behaviours, with emphasis on how the determinants identified by the Health Belief Model (HBM) – one of the oldest and most widely employed model of health behaviour [158] – influence their eating behaviour. The behaviour change determinant is the basic building block of behaviour change interventions and, based on my review (in step 2), the HBM is one of the widely employed models of health behaviour promotion. I utilized the data from the study to separately model the determinants of healthy eating behaviour for the seven gamer types identified by BrainHex (discussed in detail in Chapter 2), resulting in seven separate models showing the influence of various determinants on each gamer type. I compare and contrast the models with respect to the influence of the determinants on the health behaviour within and across the gamer types. To bridge the gap between behaviour change researchers and persuasive game researchers, make the models' result actionable in game design, and make the results usable by every game designer (including those who may not have the necessary background in behaviour theories and determinants), I compiled a list of common game design mechanics and develop a mapping of determinants to game design mechanics that are immediately actionable in persuasive game design – Chapter 3.

4. **Model-driven Approach Applicability (Study Two):** Based on my review (in step 2), most PT designers use the persuasive strategies as their foundation (especially where the determinants influencing behaviours are already believed to be known), and the persuasive strategies are more broadly applied to multiple domains (and not just health behaviour). Therefore, in this step, I examined the applicability of my model-driven approach with respect to its applicability in tailoring the strategies. Specifically, I conducted a large-scale study of 1108 game players' behaviours with respect to the perceived persuasiveness of various strategies that are commonly used in persuasive games design. I used the data from the study for modelling the persuasiveness of the strategies separately for the seven gamer types identified by BrainHex, resulting in seven models showing the persuasiveness of various strategies by each gamer type. I compared and contrasted the models with respect to the persuasiveness of the strategies within and across the gamer types. To bridge the gap between

persuasive technology designers and game designers, I suggested mapping strategies to common game design mechanics – Chapter 4.

5. **Feasibility of MPG:** To demonstrate the feasibility of a model-driven approach in a persuasive game design, I employed the models' results from Chapter 4 to develop two versions of a persuasive game for promoting healthy eating called JunkFood ALIENS. The two versions were tailored and contra-tailored to two distinct gamer types using the strategies that the models in Chapter 4 describe as persuasive and not persuasive, respectively. The two versions of JunkFood ALIENS were made up of the same game features; the only difference between them was the persuasive strategy employed. I proposed and demonstrated a much easier way that PTs can be tailored to reduce cost, labor, and still increase their efficacy – the MPG approach – Chapter 5.

6. **Efficacy of MPG:** To demonstrate the efficacy of the MPG and the importance of tailoring persuasive games for promoting healthy behaviour using the MPG approach, I conducted a large-scale evaluation of the two versions of JunkFood ALIENS (developed in 4 above) on 802 participants and in a small scale follow-up study of 6 participants. I measured the efficacy of the persuasive game with respect to its ability to promote positive changes in attitude, self-efficacy, and intention to eat healthily. I evaluated the games using three experimental conditions: The tailored condition, contra-tailored condition, and the random assignment condition (the one-size-fits-all). Participants were randomly assigned to one of these three experimental conditions depending on their gamer type. Participants that were randomly assigned to the tailored condition played a tailored version of JunkFood ALIENS, i.e., a version that was implemented using a strategy that the model suggested would be persuasive, based on their gamer type. Participants that were randomly assigned to the contra-tailored condition played the contra-tailored version of JunkFood ALIENS, i.e., a version that was implemented using a strategy that the model suggested would *not* be persuasive based on their gamer type. Finally, participants in the random assignment condition were randomly assigned to play any version of the game without considering their gamer type or strategy preference – one-size-fits-all approach – Chapter 6.

The results of the evaluation show that while persuasive games can be effective for changing (eating) behaviour – attitude, self-efficacy, and intention – the effectiveness depends on using the right choice of persuasive strategy for the right gamer type. The results showed that one size *does not* fit all and answered my overarching research question of *whether there is a value in tailoring persuasive games?* – by showing that persuasive game interventions are more effective if they are tailored to the gamer types under consideration and that not tailoring persuasive games could be detrimental. I show that if PT designers do not consider the differences in the ways that people are motivated to change their behaviour, it can appear as though two different interventions are equally effective or failed equally. But by considering different groups of users and how these different groups are best persuaded, it becomes clear that there are large differences in how different types of people responded to the interventions. As predicted by my model, tailored persuasive games were more effective at motivating health behaviour change than both the contra-tailored and the one-size-fits-all games.

In summary, assuming that game players will respond in a similar manner to popular strategies employed in PT (as in the one-size-fits-all approach) is not a good approach for PT designers to take. Rather, my work shows that by employing popular strategies with the wrong type of user (as predicted by the model), designers may provoke a negative reaction (that will likely demotivate behaviour change) and, therefore, not succeed in their persuasive purpose. On the other hand, tailoring the strategies according to the model will most likely create a positive and compelling persuasive experience that will promote positive changes in behaviour. Perhaps the most important use of our model is to avoid using the wrong strategies, which may be counterproductive [103].

1.6 Contributions

This dissertation contributes in advancing the field of persuasive technology and design of interactive applications for promoting behaviour change in general by effectively answering an important question of *whether there is any value in tailoring Persuasive Technologies (PTs)*? The dissertation not only demonstrated that *one size does not fit all* (through extensive large-scale studies and models), it also effectively demonstrated that tailoring PTs can increase their effectiveness at motivating behaviour change (through implementation and large-scale field studies).

Specifically, the dissertation made five main contributions to the field of persuasive technology and design of interactive applications for promoting behaviour change.

1.6.1 Developed The MPT Design Approach

I developed the MPT design approach for tailoring PTs through two preliminary large-scale studies (N=221, N=554) that investigated and model the determinants of healthy eating for people from different cultures, of different ages, and of both genders.

In the first study, I investigated the determinants influencing fast food eating behaviour and developed models for motivating healthy fast food eating attitude. To adapt the models to various gender groups, I developed two separate models for tailoring PT to males and females. In the second study, I examined the variations in the determinants influencing healthy eating behaviour using the Health Belief Model (HBM) and developed ten different models and persuasive profiles for tailoring PT to various cultural subgroups – Chapter 2. Based on these results from the preliminary studies, I proposed the model-driven approach for tailoring PT, called MPT.

1.6.2 Developed Models for Tailoring Health Determinants to Various Gamer Types

To demonstrate the applicability of the MPT approach, I conducted a large-scale study of determinants influencing healthy eating behaviour, and developed models for tailoring behavioural determinants to various gamer types based on a large-scale study of 642 participants. The persuasive profiles from these models serve as guidelines for selecting appropriate determinants to manipulate in persuasive game interventions.

To make the findings actionable for designers of persuasive games, I mapped the determinants of health behaviour to common game mechanics that can be employed in persuasive game design. Having a personalized persuasive profile of what motivates different gamer types, and mapping these behaviour determinants to game mechanics, provides a crucial theoretical and methodological bridge between research on what motivates health behaviour change (i.e., theories) and research on designing games for health (i.e., persuasive games). The model-driven and gamer type-relevant design approaches are immediately actionable for designers to build effective persuasive games for motivating health behaviour change – Chapter 3.

1.6.3 Developed Models For Tailoring Persuasive Strategies To Various Gamer Types

I conducted a cross validation of the persuasiveness of ten commonly employed PT strategies (showing their comparative effectiveness in general) and developed models showing the receptiveness of the seven gamer types to the PT strategies based on a large-scale study of 1108 participants. I developed persuasive profiles (comprising a list of suitable PT strategies for tailorinig persuasive games) for each gamer type identified by BrainHex. Based on the results from the models, I highlighted the best overall strategies that were perceived as positive by most participants and the least efficacious strategies that were not perceived as persuasive by most participants.

Through the study and modelling, I revealed that one of the popular strategies (reward) that is often employed in persuasive games design may not effective for the bulk of people. This means that persuasive games employing reward may not be effective for promoting desired behaviour change for the majority of players and, therefore, persuasive game designers should employ reward with care.

Finally, to bridge the gap between PT designers and designers of games, I proposed a mapping of PT strategies to appropriate game design mechanics. Having persuasion profiles of various persuasive strategies that motivate different gamer types provides a crucial methodological bridge between game researchers and Persuasive Technology (PT) researchers and also between personalization researchers and PT researchers. The proposed model-driven approach for tailoring persuasive games benefits from the best practices of both game design and PT researchers – Chapter 4.

1.6.4 Developed A Model-Driven Persuasive Game

I developed two versions of a model-driven persuasive game intervention called JunkFood ALIENS-C and JunkFood ALIENS-R. JunkFood ALIENS was developed as a proof of concept persuasive game to show the feasibility of the MPG interventions that were informed by my models for tailoring persuasive games to gamer types – Chapter 4.

Through the design of JunkFood ALIENS, I show that persuasive games designers do not have to design each game version from scratch to adapt it to the target audience. Tailoring can easily be achieved by incorporating appropriate PT strategies into existing games – Chapter 5.

1.6.5 Conducted A Large-Scale and A Follow-Up Evaluation of The Model Driven Persuasive Game

To determine and compare the efficacy of tailored, contra-tailored, and the one-size-fits-all JunkFood ALIENS at promoting healthy (eating) attitude, self-efficacy, and intention, I conducted a large-scale quantitative study (on 802 participants) and a follow-up study (on 6 participants) to gain deeper insights into the dynamics of the in-game behaviours of different game types. The results showed that while persuasive games can be effective for promoting healthy behaviour – attitude, self-efficacy, and intention – the effectiveness depends on using the right choice of persuasive strategy for the right gamer type. The results from the user study answered the research question – *whether there is a value in tailoring persuasive games?* – by showing that persuasive game interventions are more effective if they are tailored to the gamer types under consideration. Not tailoring persuasive games could be detrimental because the contra-tailored persuasive game condition showed a decrease in healthy eating attitude in favour of unhealthy eating– Chapter 6.

Again, through evaluations of the two versions of Junk Food ALIENS, I showed that persuasive game designers do not have to combine multiple strategies in a single game to make it effective. Persuasive games designed using a single appropriate strategy (just as in the design of JunkFood ALIENS) could be effective.

In summary, this dissertation contributes in advancing the field of persuasive technology and design of interactive applications for promoting behaviour change in general by effectively answering an important question of *whether there is any value tailoring Persuasive Technologies (PTs)*? The dissertation not only demonstrated that *one size does not fit all* (through extensive large-scale studies and modelling), it also effectively demonstrated that tailoring PTs can increase their effectiveness at motivating behaviour change (through implementation and large-scale field studies of the efficacy of a tailored, contra-tailored, and one-size-fits all-versions of a PT called JunkFood ALIENS). The dissertation shows the values of tailoring PTs, the need to tailor PTs (by highlighting the danger of taking the one size-fits-all approach), and demonstrates much easier ways that PTs can be tailored to reduce cost, labor, and still increase their efficacy. In general, the dissertation highlighted some subtle and important design considerations for designing effective persuasive games and persuasive interventions in general. The two preliminary studies show that the

MPT design approach can be applied in tailoring PTs to non-gamers using other differentiable user characteristics, such as gender and age.

1.7 Overview of Dissertation

This dissertation contains detail of the work summarized in this introductory chapter presented in the following sequence of eight chapters.

Chapter 1: Introduction

Chapter 2: Research Background: Contains background research related to this dissertation. It includes necessary background on Persuasive Technologies (PT) for behaviour change and their various application domains, behaviour change theories with emphasis on the Health Belief Model (which is explored in this dissertation), Persuasive System Design Framework, theory-driven PT design, persuasive strategies, game-based persuasive technology for health, and gamer types. This chapter also contains my initial feasibility studies that led to the development of the concept of model-driven approach to tailoring PTs, and shows that MPT can be applied in tailoring PT to non-gamers.

Chapter 3: Tailoring Behaviour Determinants in Persuasive Health Games to Gamer Types: This chapter presents the results of the first large-scale study to test the applicability of the model-driven approach for tailoring persuasive games by applying it in tailoring behavioural determinants to various gamer types. It details the modelling process, results, persuasive profile (which could serve as a guideline for tailoring persuasive games to various gamer types using the determinants), and the mapping of determinants to various game mechanics. It also contains a review of persuasive games for health and the deconstruction of various determinants employed in the design of the games.

Chapter 4: Modeling the Efficacy of Persuasive Strategies for Different Gamer Types in Persuasive Games for Health: This chapter presents the results of a second large-scale study aimed at validating the applicability of the model-driven approach by applying it in validating and tailoring persuasive strategies to various gamer types. It details the modelling process, results, guidelines for tailoring persuasive games to various gamer types based on the persuasiveness of various strategies, and the mapping of strategies to various game mechanics. It also contains a review of persuasive games for health and the deconstruction of various strategies employed in the design of the games.

Chapter 5: Model-driven Persuasive Game Design and Implementation: This chapter describes the design and implementation of two versions of a model-driven persuasive game (called JunkFood ALIENS-C and JunkFood ALIENS-R) informed by design guidelines from the model presented in Chapter 4. It demonstrates how persuasive games can be tailored by tailoring the strategy employed – without changing the main game contents. It also demonstrates how persuasive games can be designed to focus players' attention to necessary persuasive contents.

Chapter 6: Model-driven Persuasive Game Evaluation Results: This chapter describes the evaluation and results from both the large-scale quantitative and follow-up study of the two versions of JunkFood ALIENS. The evaluation is aimed at investigating the efficacy of the model-driven persuasive game by investigating whether the game will promote a positive healthy eating attitude, self-efficacy, and intention to change. In addition, it also investigates whether players who played the tailored persuasive game will show more positive changes in attitude, self-efficacy, and intention than those who played either the contra-tailored or one-size-fits-all persuasive games.

Chapter 7: Discussion: Summarizes main findings from previous chapters, discuss some key issues, and presents implications of the findings from the dissertation for PT and interactive technology design for behaviour change and design for engagement.

Chapter 8: Conclusion and Future Work: Briefly summarizes the work presented in this dissertation, recaps the contributions, and outlines future directions for this research.

CHAPTER 2

RESEARCH BACKGROUND

Persuasion as a practice is as old as human existence. As early as 400 BC, Aristotle identified the power of persuasion when he defined ***rhetoric*** as "… ***the faculty of observing in any given case the available means of persuasion*** [9]." Whenever we communicate with a clear intended outcome, we are engaging in persuasion [182]. Early research on persuasion focused on human-to-human persuasion, which mostly took the form of a face-to-face discussion between the persuader(s) and the persuadee(s). Therefore, persuasive researchers concentrated on addressing methodologies aimed at changing the mental state of the persuadees through communication [79].

The recent discovery that similar to a human persuader, computing technologies can be designed to bring about some constructive changes in human behaviours and/or attitudes has led to an increasing interest in various ways of designing technology to influence human behaviours. In this chapter, I present an overview of Persuasive Technologies (PT) and their various application domains, behaviour change theories with emphasis on the Health Belief Model (which is explored in this thesis), Persuasive System Design Framework, Theory-driven PT design, Persuasive Strategies, Game-based Persuasive Technology for health, and gamer types.

2.1 Persuasive Technology

The study of how to design technology to motivate behaviour change has been of interest to both researchers and industrial practitioners. The pioneer of the field, Fogg [62], defined ***Persuasive Technology*** as "***a computing system, device, or application intentionally designed to change a person's attitudes or behaviour in a predetermined way***" without using coercion or deception [61,62]. It has been argued that technology is never neutral; rather, it has always influenced people in one way or another [140]. However, the influences are usually a side effect of technology use as opposed to being the planned effect of its design [61]. On the contrary, PTs are intentionally designed to change the user's attitude and/or behaviour in a particular way, i.e., to achieve a planned effect. The conscious and mindful application of various persuasive techniques in PT design to influence human behaviour in an intended way differentiates PT from other technologies that may influence people as a side effect of its use.

In the last few years, several PT interventions have been developed with the potential of promoting users' behaviour in several domains, including marketing, health, safety and security, and Environmental sustainability [14,76,77,108,145]. Marketing is the first domain and probably the domain with the most salient applications. Generally, in the marketing domain, PTs are designed to motivate customers to purchase products and services by automating a variety of strategies that have proven to be effective for decades in the consumer world. The most popular of these strategies is tracking and monitoring: PTs are designed to track consumers' online activities and their preferences across multiple stores and recommend products and services to customers based on their interest [45,104]. With the increasing growth of e-commerce, it is predicted that marketing will continue to attract PT researchers in the foreseeable future [116].

Safety and security is another significant domain of application of PT. In this domain, PTs are employed to promote safety and security and to prevent accidents. For instance, *DriveRS* is a persuasive mobile application for discouraging young drivers from speeding [22].

Environmental sustainability is yet another significant field of application of PT with the aim of motivating people to preserve or maintain the natural ecosystem. An example is "*UbiGreen*" [66], a technology that motivates users to ride on a bicycle instead of car by depicting the carbon emission from the car and its effect on the ecosystem.

As expected, health as a domain has equally received significant attention. This is because it is broad, important, and a very challenging domain. Moreover, it has been argued that most of the health challenges faced by our society today are lifestyle-related. Therefore, it might be possible to solve them by motivating people to make lifestyle changes [182]. For instance, obesity, alcoholism, smoking, and drug addiction are conditions that can be controlled with lifestyle choices and not treating them poses significant health risks. Thus, researchers are of the opinion that "*designing persuasive systems that could resolve even some small parts of these problems and aid in true long-term sustainable change would be very valuable*" [182]. An example of a PT that encourages people to form a healthy behaviour and adopt preventive measures to illness, is a game designed to encourage people to eat healthily [49,77,180]. Health becomes such an important domain because of the increasing need to improve the physical and mental well-being of individuals. Thus, this review concentrates mostly on PT for behaviour change with an emphasis on promoting healthy eating behaviour. Occasionally, examples from other fields, mentioned above, will be used to illustrate some points.

2.2 Behaviour Change Theories

Health behaviour theories assist in understanding health behaviour problems, developing interventions based on salient determinants that affect behaviours, and evaluating the effectiveness of the health interventions. The most effective persuasive interventions for behaviour change usually occur when the intervention is behaviourally focused and theory driven [44]. Therefore, PTs can be made optimally effective, if they are also informed by these theories [165]. According to Kharrazi and Faiola [113], using behavioural models to inform interventions for health can increase the usability and the effectiveness of the intervention at achieving the desired outcomes. Theory helps designers move beyond intuition to designing and evaluating health behaviour interventions based on an understanding of human behaviour. This is because behaviour determinants can be identified from behaviour theories.

Decades of research on human behaviour and what motivates people to change their behaviour have resulted in several theories of human behaviour in use today (e.g. [4,153,158]). Several of these theories address health behaviour and have been used to inform persuasive health intervention designs, for example, the Theory of Planned Behaviour [4], the Transtheoretical Model [153], and the Health Belief Model [158]. The most frequently applied health behaviour theory is the Health Belief Model (HBM) [158], shown in Figure 2.1. Developed in the 1960s, it remains one of the most widely employed theories of health behaviour and focuses on why people fail to undertake preventive health measures. The HBM was developed to address problem behaviours that evoke health concerns. It postulates that an individual's likelihood of engaging in a health related behaviour is determined by his/her perception of the following six variables: *Perceived susceptibility* (perceived risk for contracting the health condition of concern); *Perceived severity* (perception of the consequence of contracting the health condition of concern); *Perceived benefit* (perception of the good things that could happen from undertaking specific behaviours); *Perceived barrier* (perception of the difficulties and cost of performing behaviours); *Cue to action* (exposure to factors that prompt action); and *Self-efficacy* (confidence in one's ability to perform the new health behaviour). These six health determinants identified by HBM together provide a useful framework for designing both long and short-term behaviour change interventions [71]. HBM focuses mainly on health motivators; therefore, it is most suitable for addressing problem behaviours that have health consequences (e.g., unhealthy eating and physical inactivity).

Considering that HBM is a well-established model that originated in the 1960s, one may argue that it is outdated and may not be a useful framework for handling recent health challenges such as obesity; however, this is not the case. HBM has recently been shown to successfully predict healthy eating behaviour, weight, and obesity management by several researchers [51,94,114,143,144]. It has also been adapted and successfully applied in the design of many technological interventions for motivating healthy eating. For example, Winett et al. [195] employed HBM to design a computer-based intervention aimed at motivating the purchase of food lower in fat and higher in fiber. The result of the evaluation revealed the efficacy of the intervention at motivating healthy dietary choice. Similarly, Campbell et al. [35] employed HBM to design a computer-tailored intervention aimed at increasing the consumption of fruits, juice, and vegetables, and reducing fat intake. Participants received behavioural feedback tailored to their beliefs about perceived dietary risks, consequences, and self-efficacy expectations with regard to dietary change. Other researchers have used the concepts in HBM, without specifically addressing the model. For example, Grimes et al. [77] designed a game called *OrderUP!* to help players learn strategies for healthy eating choices. *OrderUP!* manipulated the perceived *susceptibility* and *severity*. Another application of HBM is *RightWay Café* - a role playing game that employs *benefit, barrier,* and *self-efficacy* to promote healthy eating and physical activity [149]. For a review of both implicit and explicit applications of HBM in health intervention design, see [143].

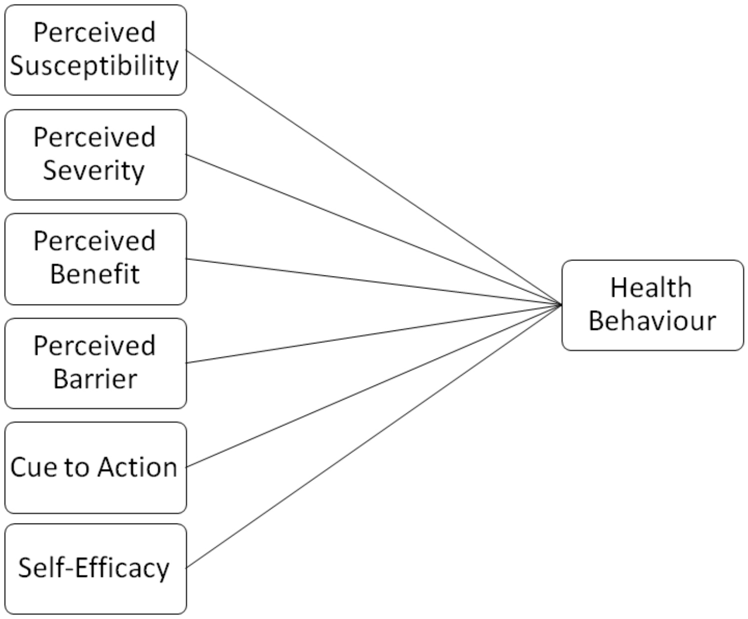


Figure 2.1: The Health Belief Model

2.3 Persuasive Systems Design Frameworks

Following the work of Fogg [62], several research efforts have been invested into developing frameworks and approaches to guide the design and evaluation of PT. The two most popular of these frameworks are Fogg's 8-step design process [63] and the Persuasive System Design (PSD) framework by Oinas-Kukkonen and Harjumaa [139]. Fogg [63], summarizes the process that PT designers can follow to design PT interventions into eight distinct steps:

1. **Choose a simple behaviour to target:** This often requires breaking down the big goal into a sequence of seemingly tiny objectives that anyone can easily achieve.

2. **Choose a receptive audience:** In the second step, Fogg advocates that the designer should know the target audience. According to Fogg [63], "*finding the right combination of behaviour and audience is vital to laying the foundation for the subsequent steps in the design process.*"

3. **Find what is preventing the target behaviour from being performed:** The designer should determine what is preventing the behaviour – is it lack of motivation? Lack of ability? Lack of a well-timed trigger to prompt behaviour performance? Or is it a combination of the three factors? This step entails a critical examination and analysis of the target audience in the light of their motivation and the determinants of the target behaviour. The behaviour theories are vital in studying users, their motivations, and behaviours.

4. **Choose an appropriate technological channel to reach the target audience:** Decision on the appropriate channel often depends on the first three steps of this design process. Therefore, designers cannot decide on the appropriate channel until the first three steps have been completed. The best channel usually depends on three factors: the target behaviour, the audience, and what is preventing the audience from adopting the behaviour.

5. **Find previous examples of PT that are relevant to the current problem:** One of the challenges in finding relevant examples, as identified by Fogg is that the design team will not always know if a given PT intervention is successful. Another possible challenge is that the PT intervention must be targeting the same or similar audience, same behaviour, and the same factor should be preventing the audience from adopting the behaviour. Most existing PTs do not make explicit these factors because they are neither based on behaviour theories nor on any form of data about the audience.

6. **Imitate successful other:** The success of this stage is heavily dependent on the user study in step 3, without which designers might develop a 'square peg for a round hole' by either matching the wrong audience, wrong behaviour, or targeting entirely different factors influencing behaviour. To date, imitating successful PTs has not been easy because most PTs are built on many assumptions about the users, the target behaviour, and the factor influencing behaviour. I argue that unless there is a systematic way of investigating the users, their behaviours, the factors influencing them, creating persuasive profiles of the users, and tailoring PT interventions to users, developing PT interventions will be informed mainly by guesswork.

7. **Test and iterate quickly:** This step encourages iterative development. A series of small rapid tests is more effective than one big test.

8. **Expand on success:** PT designers can expand on success by making the target behaviour more complex or by including new audiences. The expansion should be gradual and systematic – varying one or two attributes from the success achieved in step 7.

Similarly, the PSD framework [139], proposes a three-step approach to the analysis and development of PT intervention design as:

1. Designers should understand the key issues behind PT intervention;
2. Designers of a PT should analyze the persuasion context to understand the intent, the event, and the strategy;
3. Designers should consider the persuasive strategies to be employed in PT design.

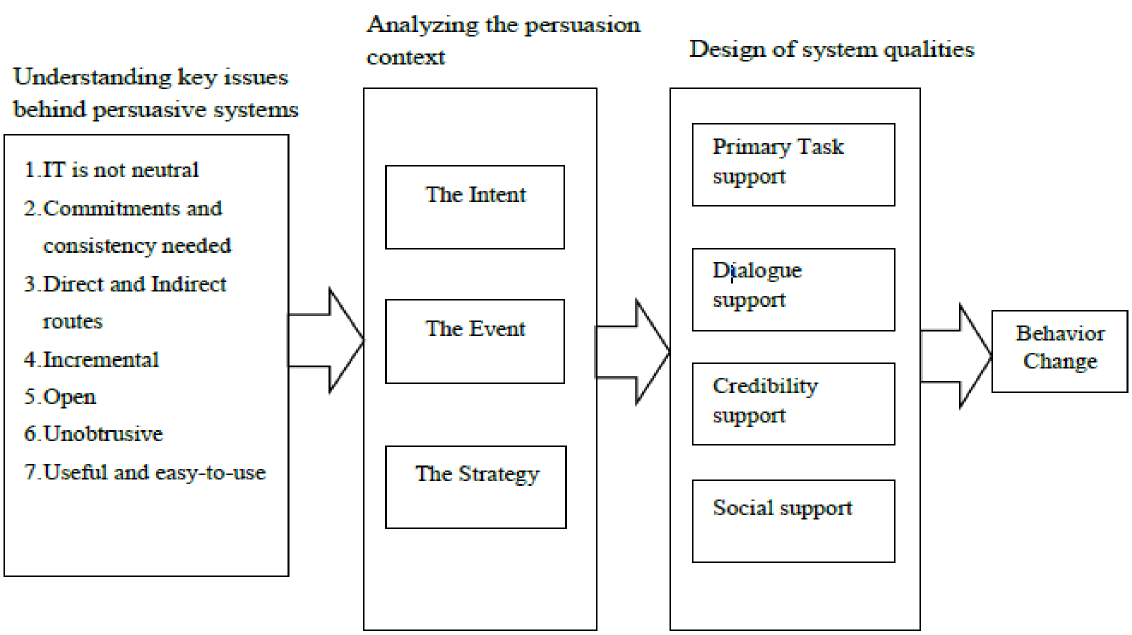


Figure 2.2: The Persuasive System Development Framework. Adapted from [139].

Figure 2.2 depicts the three steps of PT design framework. The first part of the framework facilitates the understanding of the key issues behind every PT intervention and includes seven postulates:

1. Computing systems are never neutral; they influence people either as a side effect of their use or a direct result of their use.
2. People like their views about the world to be consistent and persuasive technology should apply the principle of consistency to make users' committed to it.
3. Direct and indirect route are key persuasive strategies and should be applied with a knowledge of the user.
4. Persuasion is often incremental. Persuasive systems should promote behaviour change my allowing users to make simple incremental steps towards the behaviour
5. Persuasion through persuasive technology should always be open. Designers should not persuade users using information.
6. Persuasive technology should aim at unobtrusiveness. They should avoid interrupting users' primary tasks.
7. Persuasive systems should be both useful and easy to use.

The first and the second postulates deal with our view of the users of technology in general. Technology does not just exist; it always influences people's behaviour in one way or the other. The third and the fourth postulate relate to strategies used in persuading people and the last three postulates address the actual system features desired of any persuasive technology [139]

The second and the third part of the PSD framework focus on the choice of strategies needed for PT development. The persuasion context, which is the center of PT intervention design, consists of the *intent, event,* and *strategies.*

The intent deals with understanding the *persuader* –usually the designers of the PT intervention – and the behaviour *change type* they aim to achieve using the persuasive system.

The event deals with understanding the *use, user,* and *the technology context.* The analysis of the *use context* answers the question – what problem-domain-dependent features in the form of well-known problems are the designers aiming to address with the PT intervention? This involves an understanding of the behaviour that the PT is aiming to promote or change (e.g., to promote healthy eating). This is based on the assumption that the choice of strategies to employ in PT design might not only vary based on the target audience but also on the target behaviour. For instance, PT strategies and behavioural determinants that are successful in developing a smoking cessation intervention might not be directly transferable to healthy eating intervention design. This is because unlike smoking, eating is one of the essentials of life; we need to eat to get the essential nutrients needed to survive. This makes analyzing and understanding the use context part of the prerequisite for a successful PT intervention design.

The *User Context* describes the individual differences between people that can influence their behaviour, the choice of PT strategies and behavioural determinants, and even the choice of technology. An analysis of the user context aims to answer the questions:

1. Who are the target users as a group? (e.g., girls, old or young age group, culture).
2. What are their motivations, lifestyle, preference, and determinants of behaviour?
3. What constrains them from adopting the behaviour (e.g., eating healthily)?
4. What is specific to the users (i.e. what are the users' characteristics) with regard to what they are to be persuaded of? [33].

Understanding the user context is the most important aspect of a PT intervention design because user acceptance and use of the PT intervention is necessary to induce the desired effect. Studying and understanding the user group is a prerequisite to designing a PT that will be appropriate for the target group. Unfortunately, PT designers have largely ignored this so far. This is something I want to correct with my research.

The *technology context* deals with the technology-dependent features. The choice of technology depends on many factors, including: the target behaviour, the target audience, and the desired persuasive strategies. For instance, there might be differences in PT strategies used in mobile phones and the ones used in desktop computers – for example, the use of alerts or reminders may be more suitable for mobile applications, where the technology can be assumed to be with the user at most times. However, the best technology platforms are always those that are common among the target group and the ones that they are familiar with. Since the beginning of the PT field, the majority of researchers' attention has been focused on exploring the technology context and this has resulted in numerous PT applications, the majority of which employ the one-size-fits-all approach in their design. The PSD encourages the understanding of the context of use, the user, and the technology to inform the choice of PT intervention functionalities.

Both the PSD framework and Fogg's PT design process are very useful frameworks and have been widely employed by PT designers. However, they provide no information or insight on how

PT interventions can be tailored to a particular audience and/or behaviour based on the PT strategies and the associated factors that influence the behaviour (behavioural determinants). For instance, although the PSD is useful in PT analysis and design, research has noted that the lack of explicit information on how to decide on suitable strategies for a particular behaviour and audience as a major limitation that impedes its appropriate use [193]. Several researchers have acknowledged the complexity of the widely used PSD framework. For instance, Kaptein et al. [100] identified a need to adapt the means to persuasion by adapting the various influence strategies. Aretaga et al. [11] identified the need for present persuasive system design techniques to be adapted to account for variations in personalities. Similarly, Halko and Kientz [81] in their exploratory study confirmed that certain persuasive strategies are preferred more by users with particular personalities. Hence, there is a need to consider the influence of various factors (e.g. behaviour determinants and PT strategies) on the users' behaviour as part of the PT design and to tailor PT interventions to various users' characteristics.

2.4 Theory-driven Persuasive System Design

Both Fogg's 8-step process and the PSD model emphasize the importance of understanding the users, and the factors influencing the target users' behaviour, but they provide no specific information on how to design theory-driven PT by including the behavioural determinants into their frameworks. It is difficult to study and understand what factors influence the target users without referencing the existing behaviour theories. As a result, Michie et al. [134] developed a framework, based on the proposed casual modeling approach by Hardmen [82], highlighting the steps that could be followed by PT intervention designers to achieve theory-driven PT, as shown in Figure 2.3.

According to this framework, the first step towards developing theory-driven behaviour change intervention is to identify the determinants influencing the behaviour. This is based on the fact that behaviour change can be achieved by targeting the determinants that influence the target behaviour in the target audience. Selecting appropriate determinants to target in any behaviour change intervention often involve two stages:

1. The first stage is to conduct a systematic review of behaviour theories and interventions aimed at similar target behaviour. The review often reveals relevant determinants – from a single theory or a combination of theories – that influence the target behaviour.
2. The second stage is to establish the applicability of the identified determinants in stage 1 to the target group using focus group study [82].

Due to the amount of work involved and the multitude of expertise required (e.g. in behaviour theory, human study, technology design, and evaluation) to develop a theory-driven PT intervention that is tailored to the target audience, most PTs that claim to be theory-driven often ignore the second stage – identifying the applicability of the determinants to the target group. PTs in this category, e.g [113,128,145,149], are usually developed using determinants identified from the theories and from the literature without actually establishing the suitability of the determinants for the target group prior to PT design. This makes it difficult to identify what determinants worked and why they worked in certain PTs and not in others. It also increases the possibility of developing a 'square peg for a round hole' by matching the right audience with the wrong determinants.

The second step in the framework for developing theory-driven interventions according to Michie et al. [134] is to identify techniques (strategies) to change the behavioural determinants. Step 3, as can be seen in Figure 2.3, is to identify the link between the behaviour determinants and the behaviour change strategies. Step 1 – identifying the behavioural determinant – could be optional. In some cases, PT designers can start from Step 2 – identifying strategies – if the determinants influencing the target behaviour are already known. However, even in such cases, designers still need to identify the appropriateness of various strategies for the target audience. This is because more than one strategy can be employed to influence change in a single determinant [134] and in the literature there is no clear mapping of determinants and strategies.

The following sections present my initial experiences with designing theory-driven PTs, which provided insights and solutions into the problem of the one-size-fits-all approach to PT development. This initial research provided the basis of the approach used in addressing the main research problem of this dissertation.

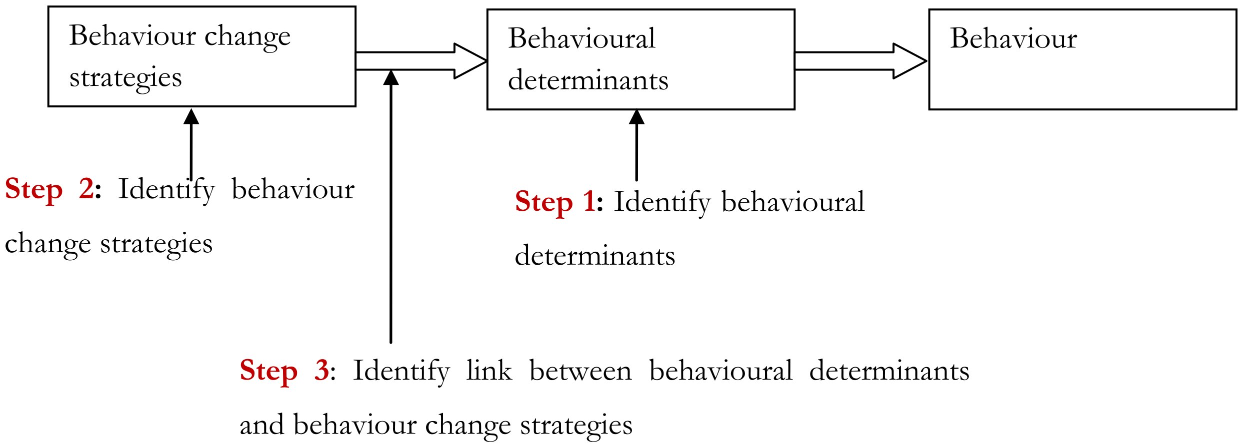


Figure 2.3: Theory-driven behaviour change intervention development framework. Adapted from Michie et al. [134].

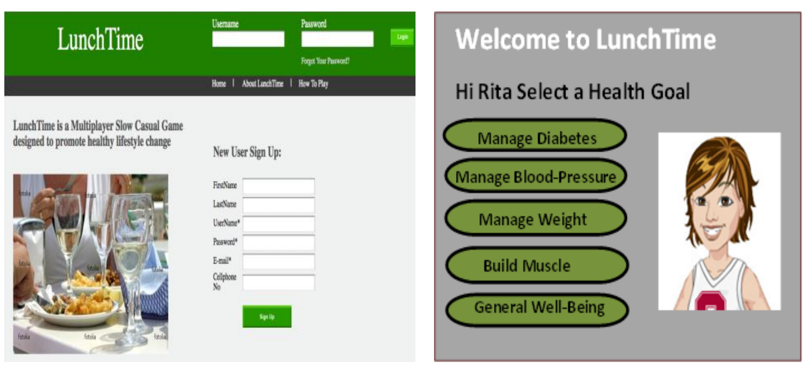
2.4.1 Experiences with Theory-driven Persuasive Health Intervention

Since there is no agreed upon approach for designing theory-driven PTs that are tailored to the target audience, similar to many PT researchers, I previously developed a PT using the one-size-fits-all approach. Specifically, I designed a theory-driven PT that was not tailored to the target user – ignoring stage 2, establishing the applicability of the identified determinants to the target group. Following the insight from the evaluation of my prototype PT (presented in Section 2.4.1.1), I conducted large-scale studies and created models to investigate whether the influence of the determinants on health behaviour vary depending on the user group, presented in Sections 2.4.1.2 and 2.4.1.3. The models could guide PT designers in deciding on the determinants to manipulate when designing PT for promoting healthy eating targeted at various user groups.

2.4.1.1 The LunchTime Game Intervention

I designed a theory-driven PT called *LunchTime* [145]. LunchTime is a slow-casual game that manipulates *perceived benefit, social influence, self-efficacy,* and *attitude* to motivate healthy eating behaviour. 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 based on the relative healthiness of their choice. The point reward can be likened to a *perceived benefit* associated with the healthy choice (choosing a healthy food option) and each player is allowed to view and compare their points with that of other players displayed in a leaderboard – *social influence*. To build *self-efficacy*, players were provided intermediate feedback after each choice and comprehensive feedback at the end of a game round.

Although LunchTime could be adapted to various player's health goals (e.g., manage weight, build muscle), as shown in Figure 2.4, the behaviour determinants of healthy eating identified from the literature – perceived benefit, social influence, and self-efficacy – were not tailored to the target audience (young adults). To evaluate the game, six participants (3 males and 3 females) played the game for 10 days. The evaluation consisted of pre (baseline) and post (exit) surveys used to determine any change in ***attitude*** as a result of playing LunchTime (the questions used in assessing healthy eating attitude is included in the appendix). The surveys were augmented by a semi-structured interview. The analysis of the pre and post survey questions about healthy eating attitude showed an increase in the mean score from 1.9±0.5 (38% on a 5-scale) in the baseline survey to the mean score of 4.2±0.5 (84%) in the exit survey. This shows that playing LunchTime led to a positive attitude change in favour of healthy eating behaviour.



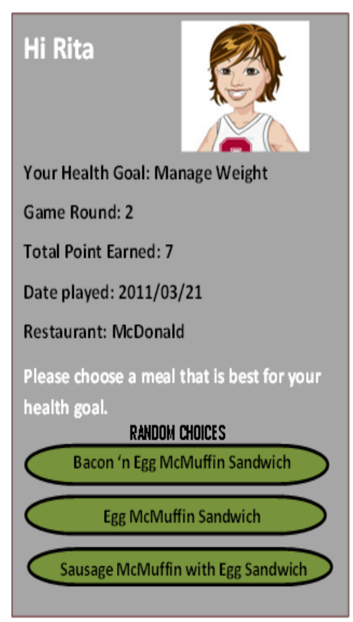


Figure 2.4: LunchTime Screen shots. (Far left) Login screen is the first screen presented to the user. It contains the signup for new users and login for returning users. (Middle) Health Goal Screen allows the player to choose a health goal for the game session. (Far right) Game Panel Screen displays the food choices and gives users the opportunity to pick the best food that corresponds to their health goal.

Despite the fact that LunchTime proved effective at achieving the intended objective of motivating a positive change in attitude towards healthy eating, it also raised some questions that deserve attention.

1. Are all the determinants employed in the design of LunchTime positively associated with healthy eating behaviour for young adults?
2. If no, which determinants are positively and significantly associated with healthy eating behaviour that should be emphasized in the design of PT targeted at adults and which determinants should be excluded or avoided?

2.4.1.2 Fast Food Eating Behaviour Survey and Model

In an attempt to answer the questions raised in the previous section and to also contribute to research on ways of tailoring determinants, I decided to investigate the determinants influencing fast food eating behaviour in adults. To achieve this, I started the study by reviewing the literature, [36,51,65,77,95,145,149,173,180] which led to the identification of five determinants that are commonly employed in developing interventions to influence fast food eating behaviour: *social influence* [49,96,145,150], *nutrition knowledge* [36,145,180], *health concern (concern for disease* and *weight concern)* [173,180], and *food choice motive* [170,173]. The scales used in measuring these determinants were adapted from previous research.

Health concern measures the participants' "degree of concern about food and health related issues". I decided to separate this determinant (Health Concern) into two variables: Weight Concern (WC) and Concern for Disease (DC), based on the factor loadings and suggestions by previous studies [173]. The scale used in measuring Health Concern has been validated by several studies [168,173]. Food choice motive measures several factors and their relative importance to the participants in making daily meal choices. The factors refer to health and non-health related food characteristics that might be taken into account when choosing what to eat. Some examples includes "It is convenient", "It is healthy", and "It is cheap". I adapted the 11 items from the food choice motives questions developed by Steptoe et al. [170] and measured attitude towards healthy eating using a 3-item scale adapted from Kearney et al. [107]. To assess nutrition knowledge, I adapted the questions developed by Alexander [6]. The questions were designed to solicit participants' knowledge about fast food meals by allowing them to rate the subjective nutrition quality of some selected fast food meals. The social influence variable was included to determine the influence of others on purchase decisions. This particular question was deemed necessary because, although several researchers have shown the important role that others play in motivating certain behaviours, the degree of social influence and its relationships with other variables are still unclear.

Following from this, I conducted a mixed-methods study with 221 visitors in 10 fast food restaurants within the University of Saskatchewan (UofS) campus. The participants were all adults (that were at least 18 years of age) at the time of data collection. The collection of primary survey data was followed by a 5-minute interview with 15 randomly-selected participants. Finally, I employed the Partial Least Square (PLS) Structural Equation Modeling (SEM) to explore the relationships between various determinants and healthy fast eating food eating attitude. SEM is a recommended approach for modeling of relationships between variables [120] and it has been successfully used in building models and estimating relationships between various determinants and several behavioural factors (e.g., see [56,57,88,141,173]). PLS is a prediction-oriented approach to SEM that has less stringent requirements concerning data distribution assumptions [86]. I present the detail of the modelling using SEM in Chapter 3, where it is used again in addressing the research question of this dissertation.

SEM was used to exhaustively explore relationships between the determinants and to generate a predictive model showing the relationships between the determinants and fast food eating behaviour in adults. The five factors (weight concern, concern for disease, nutrition knowledge, social influence, and food choice motive) were included as latent (independent) variables, and each was hypothesized to have a direct effect on health fast food eating attitude – the dependent variable.

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) [57]. Path coefficients measure the influence of one variable on another. The individual path coefficients and their corresponding level of significance obtained from the data collected are shown in Figure 2.5.

The determinants vary with respect to their influence on healthy eating attitude. Among all the variables, concern for weight and nutrition knowledge exhibits the strongest direct influence on healthy eating attitude. Thus, persuasive interventions targeted at motivating healthy fast food eating in younger adults should emphasize the relationship with weight rather than diseases. Furthermore, the model suggests that knowledge is an important factor in the design of healthy eating persuasive interventions. This means that integrating healthy eating education in persuasive interventions may be helpful. Contrary to expectations, social influence and concern for disease show no direct significant relationship with attitude, therefore, they could be ignored by PT designers targeting the young adults user group. The results show that food choice motive is negatively associated with healthy fast food eating attitude. Therefore, persuasive researchers targeting healthy fast food consumption should effectively plan to deal with the inhibiting and the mediating effect of the food choice motive on healthy eating attitude. Overall, the results as shown in Figure 2.5 show that some determinants that have been used to influence behaviour (identified from the literature) have no significant relationship with healthy fast food eating attitude for young adults (e.g., social influence [62,139]) while others are negatively associated with healthy fast food eating attitude (e.g., food choice motive). The results shed light on important determinants that adults consider when forming healthy fast food eating attitudes. The path values presented in this model are statistically significant at $p \leq 0.05$.

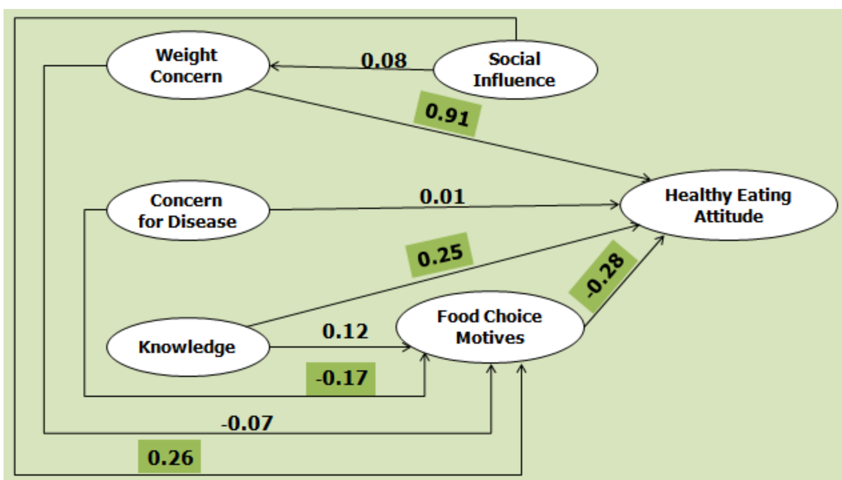


Figure 2.5: A Path Model of Healthy Eating Attitude. Highlighted coefficients are significant at $p<.05$.

To investigate whether these determinants impact males and females differently, in the second stage of the research, I investigated 228 participants (104 females and 124 males), I developed separate models for both males and females. After establishing measurement invariance, I assessed for significant structural difference and moderating effect using the pairwise comparison approach recommended by Chin [39].

The results from our models show that males and females differ with regards to the influence of the determinants (*concern for disease* and *nutrition knowledge*) on their healthy eating behaviour (see Figures 2.6 and 2.7). For males, weight concern emerged as the only determinant that is positively and significantly associated with healthy eating behaviour. Concern for disease, nutrition knowledge, and social influence are not significantly associated with fast food eating attitude for males and therefore may not be employed in designing PT targeting adult males. On the other hand, for females, all the determinants apart from social influence are significantly associated with fast food eating attitude and should be emphasized in the design of PT interventions targeting females.

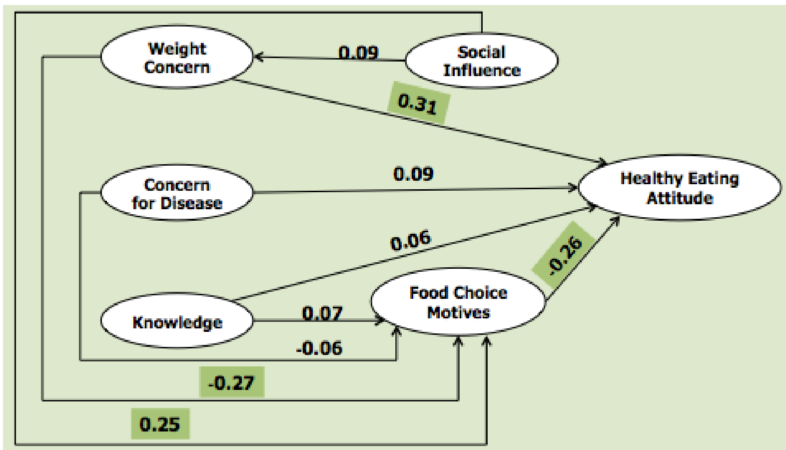


Figure 2.6: A model of healthy eating attitude and associated determinants' relationships for males. Significant coefficients are highlighted.

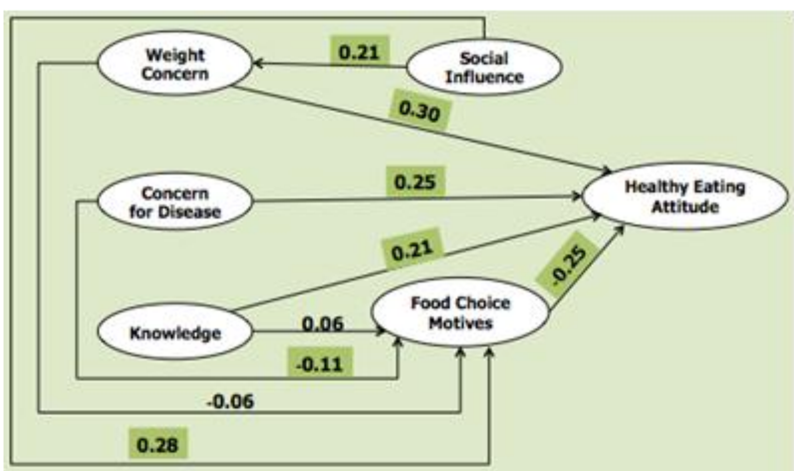


Figure 2.7: A model of healthy eating attitude and associated determinants' relationships for females. Significant coefficients are highlighted.

The discovery that the determinants differ with respect to their influence on healthy fast food eating attitude and that their influence on attitude further varies depending on the gender group raised further questions:

1. Is the variation on the influence of the determinants only applicable to fast food behaviour or is it applicable to general eating behaviour?
2. Is it possible that determinants from frequently used theories (such as HBM) would also vary with regard to their influence on healthy eating behaviour for adults?
3. Is it also possible that the influence of the determinants will vary based on other users' characteristics (e.g., culture and age) apart from gender?

2.4.1.3 Health Behaviour Model Study

In an attempt to answer the questions resulting from the fast food survey and models and to also contribute to research on ways of tailoring behavioural determinants, in the third piece of preliminary research, I investigated the influence of determinants identified by HBM on healthy eating behaviour.

Section 2.4.1.2 suggested the need to tailor PT interventions and develop models that could serve as a guide for tailoring PT interventions to gender groups. In this section, I further this understanding by examining for possible cultural variations in the determinants of healthy eating behaviour as identified by HBM. The success of many interventions aimed at motivating healthy behaviour change will be related to the degree to which cultural and contextual factors are taken into consideration in the intervention design [2]. What is eaten and how it is eaten is the primary cause of obesity and culture is at the core of what we eat, how we eat, and with whom we eat [2]. Eating is a way of expressing cultural identity.

Recent attempts to investigate empirically the differences in cultures based on the value system shared by various groups identified five finite and crucial cultural dimensions [90], which include: *Collectivism* versus *Individualism, Femininity* versus *Masculinity, Long-term* versus *Short-term orientation, Power-distance,* and *Uncertainty avoidance*. At present, much of cross-cultural research has been focused on the individualism and collectivism dimension. Research has shown that the individualism and collectivism dimension accounts for most of the variance in global differences (Hofstede, 1996; Khaled et al., 2006; Triandis, 1995). Thus in this dissertation, I rely on these two important and well-researched dimensions: *individualism* and *collectivism* to study cultural differences in healthy eating determinants.

A major distinguishing factor between *individualist* and *collectivist* cultural orientation is the relationship that individuals perceive between one's self and the one's in-groups. In an *Individualist* culture, there are loose ties between individuals and people are expected to look after themselves and their immediate families at the very most. Compared to people in collectivist cultures, people in individualist cultures tend to be more independently minded, self-centered, self-oriented, competitive, less cooperative, and less concerned with their in-groups goals, needs, beliefs, norms, and consequences. Individualists are less loyal and less cooperative to the extent that individual interests outweigh group interests. Individualists tend to be self-motivated, goal-oriented, and they use guilt and loss of self-respect as motivators [90,109,178]. In addition, individualists exhibit more consistent attitude-behaviour patterns than collectivists, are more interested in duties that are of benefits to themselves, and consider the individual self as a determinant of his/her self-identity, purpose, and goals [109,178,184]. On the other hand, in *collectivist* society, from birth, people get integrated into strong cohesive groups. The collectivist expects other in-group members to look after them and protect them in exchange for unquestioning loyalty [109,178,184].

I conducted a mixed-methods study of 554 participants' (collectivist = 306 and individualist = 247) eating behaviours and associated determinants. The quantitative component was designed to elicit participants' responses to surveys that would assign participants to a cultural dimension (using Hofstede's cultural model [90]) and weightings to the six determinants of healthy behaviour identified by the HBM. I was specifically interested in determining the influences of the six health determinants (1) *perceived benefit;* (2) *perceived barrier;* (3) *perceived susceptibility;* (4) *perceived severity;* (5) *cue to action;* and (6) *self-efficacy* on *health behaviour* as they apply to decisions around healthy eating behaviour. The qualitative part, which involved a 10-minute interview with 20 randomly-selected participants (collectivist = 10 and individualist = 10) aimed to elucidate the reasons behind the behaviours, and to clarify responses from the survey.

The only eligibility criterion was that participants were at least 18 years old at the time of data collection. This is in compliance with the study ethics approval and to ensure that the participants were of legal age to make decisions independently (including decisions on what to eat).

I employed Confirmatory Factor Analysis (CFA) and used Partial Least Square (PLS) Structural Equation Modeling (SEM) to develop models of healthy eating determinants for the cultural groups.

I also developed additional four models (one for each of the males, females, young adults (18-25), and old adults (over 45) to examine for possible moderating effect of age and gender and establish the generalizability of the results.

The structural models determine the relationship between the determinants (susceptibility, severity, benefit, barrier, cue to action, and self-efficacy) and health behaviour. I present the detail of the modelling using SEM in Chapter 3, where it is used again in addressing the research question of this dissertation.

The individual path coefficients and their corresponding level of significance obtained from the ten models are summarized in Tables 2.1, 2.2, and 2.3. The results from our models reveal some interesting similarities and differences between participants from individualist and collectivist cultures, males and females, and younger and older adults with respect to the influence of the six HBM determinants on their healthy eating.

Table 2.1: Standardized path coefficients and significance of the models for individualists and collectivists cultures. The numbers represent coefficients that are significant at least at $p < .05$ and '-' represents non-significant coefficients.

	SUS	**SEV**	**BAR**	**BEN**	**CUA**	**EFF**
Collectivist	-	-	-	.36	-	-
Individualist	.11	.14	-.22	.19	-	.46
SUS = perceived susceptibility, SEV = perceived severity, BEN = perceived benefit, BAR = perceived barrier, CUA = cue to action, EFF = self-efficacy						

Among the six determinants theorized to influence healthy behaviour by HBM, perceived benefit emerged as the only significant motivator of behaviour change for the collectivists. However, for individualists, perceived severity, cue to action, self-efficacy, and perceived benefit significantly influenced healthy eating behaviour. Perceived barrier is the only determinant that influenced healthy eating behaviour negatively. A possible explanation of these results can be found in the characteristics of the collectivist and individualist cultures – individualist culture encourages individual identity and fosters achievements of individual goals, whereas in the collectivist cultures, emphasis is placed on group identities and individuals are encouraged to cooperate in order to achieve group goals [60]. Healthy (eating) behaviour and the associated determinants as highlighted by the HBM emphasize individual actions and perceptions and their effects on individual's health with little or no emphasis on in-groups – the group of people about whose welfare a person is concerned. Therefore, these determinants (with the exception of benefit) might not motivate the collectivists to adopt a healthy eating behaviour. This result is related to those of Khaled et al. [111], who suggest that various persuasive strategies used to date are mostly suitable for individualists and not for collectivists.

To further explore possible variations and generalizability of our cultural models, we examined the moderating effect of gender and age within the individualist and collectivist cultures. The summary of the model's results are as shown in Tables 2.2 and 2.3.

Table 2.2: Standardized path coefficients and significance of the models for the males and females within the individualists and collectivists cultures. The numbers represent coefficients that are significant at least at $p < .05$ and '-' represents non-significant coefficients.

	SUS	SEV	BAR	BEN	CUA	EFF
Collectivist Females	.24	-	-.15	.46	-	-
Collectivist Males	-	-.26	-	-	.15	-
Individualist Females	.19	-.21	-.18	.21	-	.16
Individualist Males	.13	.11	-.27	.18	-	-
SUS = perceived susceptibility, SEV = perceived severity, BEN = perceived benefit, BAR = perceived barrier, CUA = cue to action, EFF = self-efficacy						

Collectivist Males and Females: Collectivists males and females differ significantly in their perceptions of the six determinants. Susceptibility and benefit are the two significant motivators of behaviour change for the collectivist female group, whereas for males, cue to action emerged as the single significant motivator of behaviour change. On the other hand, barrier influences behaviour negatively for females, whereas severity is negatively associated with healthy behaviour for the male group.

Individualist Males and Females: Individualist males and females share more significant similarities than differences in the influence of the determinants on their healthy eating behaviour. The determinants susceptibility, barrier, and benefit significantly influence behaviour for individualist males and females (although at different magnitudes). Susceptibility and benefit are positively associated with healthy eating behaviour, whereas barrier influences behaviour negatively for both individualist males and females. On the other hand, individualist males and females differ in the influence of severity and self-efficacy. Individualist females perceive severity as negative, whereas severity is positively associated with healthy eating behaviour for individualist males (although recall that severity was negatively associated with healthy behaviour for collectivist males). Similarly, self-efficacy is perceived as positive by individualist females, whereas it is not significant for individualist males.

Table 2.3: Standardized path coefficients and significance of the models for the younger and older adults within the individualists and collectivists cultures. The numbers represent coefficients that are significant at least at $p < .05$ and '-' represents non-significant coefficients.

	SUS	**SEV**	**BAR**	**BEN**	**CUA**	**EFF**
Collectivist Younger Adults	-	.18	-	.31	-	.25
Collectivist Older Adults	-	-	-.12	.25	-	-
Individualist Younger Adults	-.14	-	-.30	.19	.14	.17
Individualist Older Adults	.15	-.13	-.17	.25	-	.19
SUS = perceived susceptibility, SEV = perceived severity, BEN = perceived benefit, BAR = perceived barrier, CUA = cue to action, EFF = self-efficacy						

Collectivist Younger and Older Adults: The models for younger and older adult collectivists show some interesting similarities and differences. Susceptibility, benefit, and cue to action similarly influence younger and older collectivists' eating behaviours. Both younger and older collectivists perceive benefit as positive, whereas susceptibility and cue to action have no significant influence on them. On the other hand, younger and older collectivists differ in their perception of severity, barrier, and self-efficacy. Younger collectivists perceive severity as positive while severity is not significant for older collectivists. Barrier is not significant for younger collectivists, whereas it negatively influences behaviour for older collectivists. Finally, self-efficacy is positively associated with younger collectivists, whereas it is not significant for older collectivists.

Individualist Younger and Older Adults: Similar to collectivists, the models for younger and older individualists show some interesting similarities and differences. Both younger and older individualists are motivated to adopt healthy eating behaviour by benefit and self-efficacy, whereas barrier deters them from adopting healthy behaviour. However, younger and older individualists differ in their perception of susceptibility, severity, and cue to action. Susceptibility is positively associated with older individualists, whereas younger individualists perceive susceptibility as negative. On the other hand, older individualists perceive severity as negative while severity is not significantly associated with behaviour for younger individualists. Cue to action is positively associated with behaviour for younger individualists, whereas it is not significant for older individualists. Similar to the collectivists, these results suggest that the influences of benefit, barrier, and self-efficacy on individualist behaviour are similarly perceived by both younger and older individualists.

Summary of Determinants by Cultural Sub-Groups

Although many PT designers adopt a one-size-fits-all approach, the results from the models show that it is necessary to tailor PT interventions to various sub-groups (e.g., collectivist females, individualistic young people) using only determinants that are perceived as positive. The results from our models provide insights into the determinants that could be reinforced to motivate behaviour change in various sub-groups and those that should be avoided. Table 2.4 presents a summary of persuasive profiles – a list of determinants that could be reinforced to effect a positive change in behaviour for various cultural sub-groups. The listed determinants motivate a positive change in behaviour for various groups without demotivating any.

Through these preliminary studies, I establish the need to tailor PTs (by tailoring the determinants manipulated in their developments). The resulting models from this study could be used in tailoring PTs to various user groups – Model-driven Persuasive Technology (MPT) design approach.

Table 2.4: Summary of persuasive profile for motivating healthy eating behaviour for various cultural sub-groups. These determinants will motivate majority of people in the group without significantly demotivating any. '√' represents significant determinants that could be employed.

	SUS	SEV	BAR	BEN	CUA	EFF
Individualist	√	√		√		√
Collectivist				√		
Collectivist Females	√			√		
Collectivist Males					√	
Individualist Females	√			√		√
Individualist Males	√	√		√		
Collectivist Younger Adults		√		√		√
Collectivist Older Adults				√		
Individualist Younger Adults				√	√	√
Individualist Older Adults	√			√		√
Collectivist and Individualist Males	√			√	√	
Collectivist and Individualist Females	√			√		√
Collectivist and Individualist Younger Adults		√		√	√	√
Collectivist and Individualist Older Adults	√			√		√
SUS = perceived susceptibility, SEV = perceived severity, BEN = perceived benefit, BAR = perceived barrier, CUA = cue to action, EFF = self-efficacy						

2.4.2 Tailoring Behavioural Determinants to Users and User Groups in PT Intervention Design

The previous sections described my findings that PT interventions for health will be more effective if the fundamental determinants are tailored to various target groups. Specifically, my first work on the design of an interactive persuasive application showed the nnecessity of tailoring, the second work established the process of understanding the needs of various groups, and my third work showed the importance of considering multiple factors that define a person and established the approach in the domain of health. Intervention designers have already begun tailoring the fundamental determinant manipulated in PT design to the target users or user groups and have found that tailored interventions are more effective at motivating desired health behaviour change than those designed using the one-size-fits-all approach. For instance, Bourdeaudhuij and Brug [28] studied their target audience (families) and developed a tailored dietary intervention aimed at motivating healthy eating, reducing fat intake, and increasing fruit/vegetable consumption. The intervention was tailored based on individual families' perceptions of various determinants of healthy eating behaviour from the theories, including: ***attitude, intention, self-efficacy,*** and ***social influence***. The result of their study shows that the tailored intervention was more effective at reducing fat intake than non-tailored intervention. Another work in this direction is RENATA, an online-based health intervention for promoting physical activity and diet (fruit and vegetable consumption) to persons undergoing cardiac rehabilitation [155]. The intervention was tailored based on the ***perceived barrier, self-efficacy, intention, risk perception,*** and ***benefit*** of persons undergoing cardiac rehabilitation. Similarly, PACE is another theory-driven intervention aimed at encouraging regular physical activity [167]. PACE designers studied and tailored their intervention to the target audience (general practitioners) based on their ***perceived barrier, self-efficacy,*** and ***benefit*** of keeping physically active. The results of the evaluation of PACE showed that the intervention resulted in positive changes in potential determinants of physical activity. Finally, Campbell et al. [35] employed HBM to design a computer-tailored intervention aimed at increasing the consumption of fruits, juice, and vegetables, and reducing fat intake. Participants received behavioural feedback tailored to their belief about perceived dietary risks, consequences, and self-efficacy expectations with regard to dietary change.

2.5 Persuasive System Development Techniques

Section 2.4, shows that tailoring determinants manipulated in health intervention design tend to increase the effectiveness of the interventions at promoting intended behaviour change. However, in most cases, these determinants are not directly implementable in PT design; therefore, various persuasive strategies have been developed for influencing changes in the determinants. These strategies are easily implementable in PT design. Therefore, according to Michie et al. [134], the second step in the framework for developing intervention is to identify strategies to change the behavioural determinants. Persuasive strategies are techniques that can be employed in PT design to motivate change in behavioural determinants and hence change in behaviour and/or attitude. Over the years, a number of persuasive strategies have been developed. For instance, Cialdini [40] developed six persuasive principles, Fogg [62] developed seven persuasive tools, and Oinas-Kukkonen [139] built on Fogg's strategies to develop comprehensive strategies consisting of 28 persuasive system design principles. The strategies developed by Oinas-Kukkonen have been most widely employed in PT design, hence, I focus my review on these strategies as highlighted in the Persuasive System Design (PSD) Framework [140]. The PSD organized the 28 strategies into four main categories: primary task support, dialogue support, credibility support, and social support as shown in Figure 2.8.

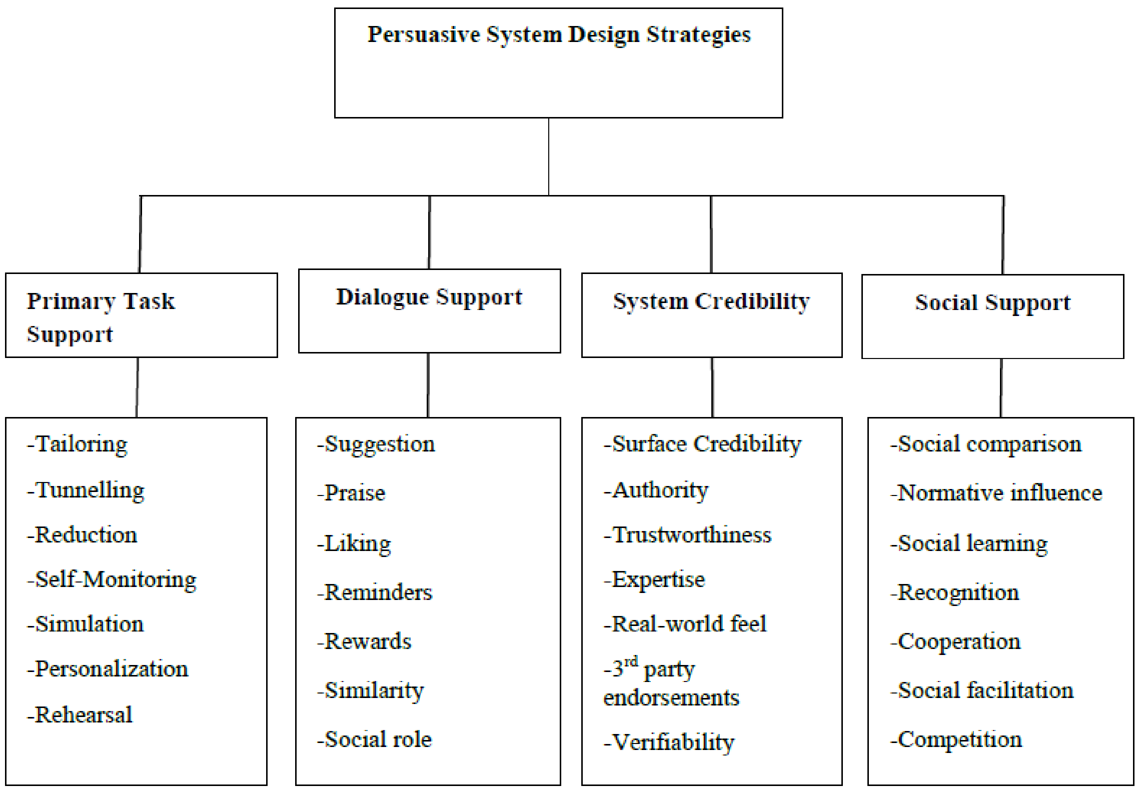


Figure 2.8: Persuasive Systems Design Strategies

Primary task: The strategies in this dimension are used to addresses the target behaviours. They deal with users' real-world tasks (target behaviour change) that the system is intentionally designed to support. In this dimension, seven strategies have been identified: *reduction, tunneling, tailoring, personalization, self-monitoring, simulation,* and *rehearsal* (see Figure 2.8).

Dialogue Support: Face-to-Face interaction has been proven to be a powerful medium for persuasion. Similar to face-to-face interaction, the *Dialogue support* enables interaction between the user and the system in such a manner that propels users toward their goals or target behaviour. The persuasive strategies in this category include *praise, rewards, reminders, suggestion, similarity, liking,* and *social role*.

System Credibility: The perceived system credibility design strategies deal with how to design a system to be more believable and thereby, more persuasive. System credibility and in particular, system trustworthiness affects users' behaviour intent [48]. Credibility is especially a problem for systems that are designed to persuade and influence users in some way. The strategies in the credibility category include: *Trustworthiness, expertise, surface credibility, real-world feel, authority, third-party endorsements,* and *verifiability*.

Social Support: Social influence uses the power of similar others to propel one towards adopting a target behaviour. This is because most of our behaviours are based on what we observe others do in the same situation. Similarly, viewing the computer as a persuasive social actor can persuade people to change their behaviour by providing some kind of social support or by leveraging social rules and dynamics [62]. The strategies in this category include: *social learning, social comparison, normative influence, social facilitation, cooperation, competition,* and *recognition*.

These strategies have been employed in developing several persuasive systems in use today (for examples, see [66,77,104,112,149]).

2.6 Game as a Persuasive Technology

Because of the motivational pull that games offer, games have attracted the attention of researchers and practitioners as a novel approach for promoting health behaviour change. Research has discovered that health games could raise players' consciousness and cause them to reflect on unhealthy behaviours [77]. Similarly, games have been found to cause an attitude change. A smoking cessation game decreased players' positive beliefs about smoking and their temptation to smoke, while increasing their negative beliefs about smoking, intention to quit, and resistance to smoke craving [112]. Various terminologies 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 behaviour [172]. Bogost used the term *persuasive game* to describe video games that mount procedural rhetoric effectively [27]. However, for the purpose of this dissertation, I define persuasive games as games that are designed with the primary purpose of changing a user's behaviour or attitude using various behaviour change theories and strategies [62]. Persuasive health games have been explored for a variety of health issues and in a variety of contexts. Here we report on three common types of persuasive health game: *exergames, serious health games,* and *casual games for health*.

Exergames is the name used for games that induce behaviour change by encouraging physical activity and fitness through game play. Most exergames use players' energy expenditure from physical activities as input to drive the game [92]. In these games, various exertion interfaces (such as electronic dance pads, bicycles, motion platforms, and motion-tracking cameras) allow the player to control the game through his/her actions, instead of using traditional electronic game input interfaces (e.g., keyboards, mouse). A well-known example is the dance simulation game, Dance Dance Revolution (DDR) [92]. DDR uses a sensor-enabled dance floor with a video interface to provide stimulating exercise as a social activity by allowing players to dance to a variety of songs. Some other forms of exergames are more ubiquitous as they extend beyond the physical activity arena (e.g., room or gym) into the players' daily lives, tracking the players' daily physical activity and energy expenditure [67,77].

"Serious game" is a term used to describe games that are driven by educational purposes. Serious games for health are designed to entertain, educate, and train players, while attempting to modify some aspect of a player's health behaviour [172]. Various serious games have been developed to impact on health behaviour in many domains. Research has shown that educational health games effectively help players develop healthier eating habits, raise consciousness about unhealthy eating, and increase their health-related knowledge [77,145]. For example, *Lunch crunch* [200] makes players fill lunch trays with fruits and vegetables and trash unhealthy food as a way of impacting knowledge about healthy and unhealthy foods. Similarly, *Escape from Diab* [180] is a serious adventure videogame on healthy eating and exercise, with the goal of preventing kids from becoming obese and developing type 2 diabetes and other related illnesses. *Trigger happy* [152] is another educational game designed to teach and warn players about the risk of "triggers" that can lead to poor eating behaviour. Serious games focus on all fields of life, but the impacts are most evident in the health field.

In recent years, casual games have become increasingly popular and important because of their simple play style. Casual games differ from serious games in that they typically offer short, less complex gameplay sessions, are easy to learn and play, and allow play on ordinary devices like personal computers and mobile phones (unlike exergames, which may require additional equipment [92]). While serious games require a minimum of 20 min to complete a session, casual games take between 1 and 10 min to complete a session and can easily be stopped and restarted [77]. These attributes make casual games suitable for different kinds of gamers (avid and casual) and attract a wider audience than traditional games [119]. A relevant example of a casual game for health is *OrderUP!* – a health-related role-playing game, where a player acts as a maitre d'hotel with the role of recommending a healthier food option to the customers. The players gain points by serving customers quickly and by recommending the healthiest food options (each customer must be served within six seconds or they will leave and players will lose points). The evaluation of OrderUP! showed that playing the game made players reflect over their dietary options, but the players desired some feedback on why a particular choice was not the best [77].

In summary, the review of related work shows that persuasive games have gained popularity as an innovative approach for motivating change in health behaviour. However, most of these games adopt a one-size-fits-all approach in their intervention design. Research has shown that players differ in motivation; therefore, the one-size-fits-all approach might not be appropriate to motivate changes in behaviour and can be counterproductive [103]. One way that persuasive games can be tailored is to adapt the PT to various player personalities, often referred to as their gamer type. The success of many persuasive games will depend on establishing a match between gamer types and the strategies employed.

2.7 Gamer Types

Now that I have established that personalization is an important factor for persuasive health games, I need to determine what aspect of a person to personalize for. This section, therefore reviews various personality models that can be used to tailor persuasive games and PTs in general. Although recent years have witnessed the emergence of many personality models, the concept of personality type has been historically associated with Myers-Briggs Type Indicator (MBTI) [135]. 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 her 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 [18]. They speak in favour of trait-theories such as the Five Factor Model (FFM) [73]. The FFM is currently the leading and most widely adopted psychological model of personality. 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 [17,179,199] raising doubts regarding the effectiveness of FFM for players' personality modelling in games [17,18]. For example, in a study of gamer type personality and game preference, Zammitto [199] found that the FFM personality factors only explained 2.6 - 7.5% of game preference. According to Bateman et al. [18] "*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 [16]. However, Bartle's typology has significant problems. For example, Bartle asserts that the four gamer types are mutually exclusive. Also Bartle's model is not empirically based and therefore, cannot be validated [54,197]. These problems make Bartle's model unsuitable as a general framework for player typology [18]. Following Bartle's discussion on player types in massively multiplayer games, Yee in his investigation [198] on why MMORPG appeals 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 is limited in relevance as a general player typology [137]. 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 [137]. Bateman and Boon [17] 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 [18]. As such, the limitations of MBTI may also extend to DGD1.

An attempt to establish a players typology that is based on play-specific foundations gave birth to the BrainHex model of seven gamer types [19]. 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 [136]. The BrainHex model identifies 7 types of players.

Achievers are goal-oriented and motivated by the reward of achieving long-term goals [136]. 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 [136,201]. They exhibit forceful behaviours and channel their anger to achieve victory and thus experience fiero (expressions of pride and emotion following victory).

Daredevils 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 the 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 player's 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 their dominant gamer types. This allows for more accurate classification.

2.8 Summary of Research Background

From the review of literature, it became obvious that persuasive technology as a field has gone a long way. Initial research efforts were focused majorly on developing some general frameworks – for guiding the design and evaluation of PTs. Similarly, several PT interventions for motivating behaviour change in various domains including health have also been developed. However, this initial work majorly focused on developing PTs for the general audience using the one-size-fits-all approach – without taking into consideration some differences in users or user group that may hinder or enhance the persuasiveness or the efficacy of such systems at achieving their intended objectives of motivating behaviour changes. Recently, researchers have begun to recognize the danger/problem of employing the one-size-fits-all approach in PT design and have called for research into various ways of tailoring PTs and designing PTs that are tailored to various users and user group. In response to this call, researchers are beginning to investigate ways that PTs can be tailored to various users and user groups. However, persuasive games which have gained popularity as a novel tool for motivating behaviour change and how they can be tailored have been largely ignored.

My dissertation fills this gap by conducting three large-scale studies where I investigated gamers' behaviours, associated determinants, and the persuasiveness of various strategies. I developed models for tailoring persuasive games to various gamer types based on the determinants (Chapter 3) and the persuasiveness of the strategies (Chapter 4). I demonstrate the efficacy of the models by developing and conducting a large-scale evaluation of two versions of a persuasive game informed by the models (Chapter 5 and 6).

In Chapter 3, I describe my research on developing models for tailoring behavioural determinants from HBM to various gamer types.

CHAPTER 3

TAILORING BEHAVIOUR DETERMINANTS IN PERSUASIVE HEALTH GAMES

In Chapter 2, I developed the Model-driven Persuasive Technology (MPT) design approach for tailoring PTs based on two large-scale studies. In this chapter, I examine the applicability of the MPT approach for tailoring persuasive games, which is the core of my dissertation.

As I discussed, persuasive games are designed as interventions with the primary purpose of changing a user's behaviour or attitude in an intended way [62]. However, these games generally take a one-size-fits-all approach, rather than tailoring their contents and strategies to individual users or user groups. Health behaviour change researchers and practitioners have overwhelmingly advocated that health interventions be tailored to account for differences in users and user group with regards to their health behaviour and attitude [103,112,155,167].

As discussed in Section 2.4, persuasive games can be tailored to different behaviour determinants. Health *behavioural determinants* is a term used in describing factors that influence an individual's health behaviour. These factors are referred to as behavioural determinants (determinants for brevity). According to the behaviour change intervention development framework by Michie et al. [134], the first step in developing behaviour change intervention is to "*identify the behavioural determinants*" Section 2.4. Several decades of research on what motivates people to change their behaviour has resulted in several theories of human behaviour and their associated determinants (e.g. [4,153,158]). However, the Health Belief Model (HBM), developed in the 1950s to investigate why people fail to undertake preventive health measures, still remains one of the most widely employed theories of health behaviour [158].

Effective tailoring of persuasive games entails tailoring the behavioural determinants manipulated in persuasive game design. As a result, in this chapter, I present a research investigating health behaviour and associated determinant of game players. Specifically, I conducted a large-scale study of 642 gamers' eating behaviour and their associated determinants of healthy behaviour to understand how health behaviour relates to gamer type. Using the behavioural data from the survey, I developed seven different models for tailoring the health determinants (*perceived susceptibility,* *perceived severity, perceived benefit, perceived barrier, cue to action,* and *self-efficacy*) identified by the Health Belief Model (HBM) [158] to the seven gamer types (*achiever, conqueror, daredevil, mastermind, seeker, socializer,* and *survivor*) identified by BrainHex [19]. I then explored the differences between the models and proposed two model-driven approaches for developing persuasive games that will effectively motivate health behaviour change. The first is an all-purpose solution approach that will motivate the majority of the population and the second is a personalized approach that will best motivate a particular type of gamer. Finally, to make my proposed approaches actionable in persuasive game design, I map common game mechanics to the theoretical determinants of healthy behaviour.

3.1 Deconstructing Game-Based Interventions with Emphasis on Determinants Manipulated

Studies have shown that games can be an effective approach for effecting behaviour change in an intended manner [110,145]. 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*. In this subsection, I present a review of persuasive health games in each category with a deconstruction of determinants from the HBM that each game manipulated.

3.1.1 Persuasive Games for Health Promotion and Prevention

Preventive health behaviours include behaviours that are undertaken by individuals for the purpose of preventing illness, detecting early illness symptoms, and maintaining general wellbeing [165]. Examples include healthy eating, being physically active, and performing breast self-exams. Several persuasive games have been developed for health promotion and prevention. *LunchTime* is a slow-casual game for motivating healthy eating [145]. 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 based on the relative healthiness of their choice. The point reward can be likened to a *perceived benefit* associated with the healthy choice (choosing a healthy food option). Similarly *OrderUP!* aims to help players learn strategies for healthy eating choices by having them play the role of a server in a neighborhood restaurant [77]. In contrast to *LunchTime, OrderUP!* portrays the perceived threat (*susceptibility* and *severity*) associated with making unhealthy meal choices by making players lose points for unhealthy choices. The decrease in cumulative points (representing a reduction in health value) portrays how eating unhealthy meals decreases one's general wellbeing and makes one *susceptible* to various health problems. Studies showed that playing the LunchTime and OrderUP! games increased the players' nutrition knowledge and their general feeling of *self-efficacy*. *RightWay Cafe* is computer game for promoting healthy eating in young adult. RightWay Cafe used perceived *benefit, barrie*r, and *self-efficacy* to influence positive changes in healthy eating attitude. Players earn points when they make healthy food choices and the virtual dietitian teaches them how to eat to build an attractive body (healthy skin, strong muscles, and better hair) - *percieved benefit.* The dietitian also teaches the players how to overcome the difficulties often associated with healthy eating – *barrier*. The game uses role-playing and feedback to build the player's *self-efficacy*. Players are presented with different food options to choose from in a trial and error basis. This is followed by a positive feedback for successful trial to build their confidents – *self-efficacy*.

Escape from Diab is an adventure game on healthy eating and exercise, with the main goal of preventing kids from becoming obese and developing diabetes and other related illnesses [180]. *Escape from Diab* employed several strategies to impact players' health belief and motivate behaviour change. These included modeling, goal review, and feedback – increasing *self-efficacy*, problem solving – impacting skills to overcome *perceived barrier,* and self-monitoring – impacting *perceived susceptibility, severity,* and *cue to action*. Finally, another successful application of *perceived barrier, benefit, susceptibility severity, and self-efficacy* can be seen in the strategies implemented in a smoking cessation application called *Smoke?* [110]. *Smoke?* is a narrative simulation game that presents six weeks of the life of a virtual character called MC. The player controls MC by deciding the course of action to increase MC's chances of quitting successfully. By so doing, players learn how to overcome *perceived barriers* associated with quitting smoking. At the end of the game, players observe the *benefits* associated with their decisions and how their decisions have affected MC's life negatively – *susceptibility* and *severity*. Players also learn and increase their *self-efficacy*. The results from the evaluation of the game-based interventions show a varying degree of success at achieving various health objectives. However, it is not always obvious which of the persuasive approaches employed made the games successful.

3.1.2 Persuasive Games for Disease Management

Persuasive 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 behaviour, and providing opportunities for players to rehearse health behaviours in relation to a specific health condition/illness [106]. 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, a game called *Re-Mission* was designed to improve cancer treatment for young adults and adolescents [105]. The task of the players of *Re-Mission* is to control a nanobot name Roxxi. Roxxi moves through the body of the cancer patients destroying cancer cells and tumors with chemotherapy and radiation – depicting the *perceived benefit* of chemotherapy. The result of the evaluation of Re-Mission revealed that patients who played Re-Mission showed increased knowledge and *self-efficacy* in relation to cancer management than patients in the control group. *SnowWorld* is a virtual reality game developed to provide a means of pain management for burn patients [89]. The game manipulated the *perceived severity* of the pain by immersing players in a virtual world where they fly through an icy landscape of cold rivers and waterfalls with gently falling snow. The evaluation of *SnowWorld* showed that it was effective in reducing pain perception among patients. *Watch, Discover, Think, and Act (WDTA)* was designed to educate children with Asthma on various triggers, signs, and corresponding actions for asthma self-management [165]. It models game challenges after asthma challenges. The game employed *cue to action, perceived susceptibility, perceived severity, barrier* and *self-efficacy.* The game challenges a child to monitor asthma symptoms and environment triggers (*cue to action*), discover if asthma exists and possible causes (*perceived susceptibility*), and then think and take action (*health behaviour action*). WDTA also increased the players' feeling of capability (*self-efficacy*) using symbolic modeling and rehearsal. In summary, a typical scenario in disease management games is that players take care of and help a game character control symptoms and manage diseases in various settings. This increases the player's self-management skills, related knowledge, and self-efficacy.

This review of games used for health-related purposes shows that games can be strategically designed to affect important health belief among players.

3.2 Study Design and Methods

Our study was designed to elicit participants' responses to surveys that would assign a gamer type and weightings to the six determinants of healthy behaviour identified by the HBM. We were specifically interested in the relationship between the six health determinants *perceived benefit, perceived barrier, perceived susceptibility, perceived severity, cue to action, self-efficacy* and *health behaviour* as they apply to decisions related to healthy eating behaviour. Research has shown that good eating behaviour can prevent – or at least reduce the risk of – many diseases including obesity, heart disease, and diabetes [192]. Therefore, eating behaviour is a focus of many persuasive games [77,145]. In this section, I first describe how I developed the research instrument; this is followed by data collection methods, validation of the data, and analyses.

3.2.1 Measurement Instrument

The online survey consisted of questions on participants' demographic information, questions of the HBM determinants, and questions for classifying gamer type. The questions used in measuring the six HBM determinants were constructed based on guidelines developed by Abraham and Sheeran [42], and have been validated on healthy eating by Sapp and Jensen [161] and Deshpande [51]. All of the HBM variables were measured using participant agreement with a 7-point Likert scale ranging from "1 = Strongly disagree" to "7 = Strongly agree". These HBM determinant questions included: (1) seven questions measuring perceived benefit (BEN) – e.g., eating healthy diets most of the time would be beneficial to me; (2) seven questions measuring perceived barrier (BAR) – e.g., eating a healthy diet is costly/hard; (3) two questions measuring perceived susceptibility (SUS) – e.g., If I don't eat healthily, I will be at high risk of some dietary-related diseases; (4) two questions measuring perceived severity (SEV) – e.g., the thought of ending up in the hospital due to dietary-related diseases scares me; (5) four questions measuring cues to action (CUA) – e.g., I would pay more attention to my meal choices if friends and family members suggest it; (6) three items measuring self-efficacy (EFF) – e.g., I am confident that I could eat healthily within the next two weeks if I want; and (7) five items measuring likelihood of behaviour – e.g., I intend to make healthy meal choices most of the time in the next two weeks. We also included the 28 BrainHex questions [201] to classify the participants into various gamer types and to investigate whether differences exist with respect to the perception of the determinants by various gamer types, see the appendix for information on the questions We recruited participants through posted announcements in high traffic websites and forums.

3.2.2 Participants

Data for this study were collected over a period of one year (from August 2011 to August 2012). A total of 710 responses were received, of which 642 were usable responses – i.e., from those who were at least 18 years old at the time of data collection, responded to all required questions, and were game players. The requirement that participants be at least 18 years of age is in compliance with the study ethics approval and also ensures that the participants were of legal age to make decisions independently (including decisions on what to eat). Participants were all computer or video game players to ensure accurate classification and mapping to the gamer types. The gamer types were well distributed across the population: *achiever* (110, 17%), *conqueror* (88, 14%), *daredevil* (67, 10%), *mastermind* (138, 22%), *seeker* (91, 14%), *socializer* (81, 13%), and *survivor* (67, 10%). This is similar to BrainHex [201] where *masterminds*, *seekers*, *conquerors*, and *achievers* are the dominant gamer types. The ages of participants were also well distributed: 18-25 (307, 48%), 26-35 (186, 29%), 36-45 (76, 12%), and over 45 (73, 11%). This distribution is similar to [12], which shows that the average age of digital game players is 30 and 63% of players are younger than 36 years. 48% (306) of all the participants were male and 52% (336) were female.

3.3 Data Analysis

The main aim of this study is to examine the relationship between the determinants and health behaviour. To achieve this, I used several well-known analytical tools and procedures. In this section, I summarize the various steps taken to analyse the data.

- First, I determined the suitability of the data for factor analysis using the Kaiser-Meyer-Olkin (KMO) sampling adequacies and the Bartlett Test of Sphericity [99]. Given these positive results, I determined that the data was suitable to conduct factor analysis [87,103].
- Second, I performed Confirmatory Factor Analysis (CFA) to establish that the data collected replicate the six determinants (from HBM) in healthy eating behaviour [46].
- Third, I employed the Partial Least Square (PLS) Structural Equation Modeling (SEM) [157] to create models showing the relationships between the gamer types and the six determinants of healthy behaviour according to HBM.
- Fourth, to establish that gamer type is a reliable characteristic for tailoring persuasive games, I performed multi-group comparison using the pairwise approach recommended by Chin [39]. Specifically, I examined the models for significant differences across the seven groups with respect to the influence of the determinants of their health behaviour.
- Finally, I employed the Bonferroni adjustment to control any familywise Type 1 error due to multiple comparisons [91]. The result showed that the observed differences in the relationships between the gamer types and the determinants were statistically significant.

3.4 Measurement Validation

To determine the suitability of the data for factor analysis, I used the Kaiser-Meyer-Olkin (KMO) sampling adequacies were all > .70 and the Bartlett Test of Sphericity was significant at $p < .001$. Thus, the data was suitable to conduct factor analysis [87].

3.4.1 Confirmatory Factor Analysis

HBM is comprised of six determinants of healthy behaviour – SUS, SEV, BEN, BAR, CUA, and EFF. To verify that the data replicate the six factors in healthy eating behaviour, I conducted Confirmatory Factor Analysis (CFA – a statistical procedure that compares the fit of the data with the factor being modeled)). Each question loaded onto their corresponding factors and the corresponding factor scores were all >.70.

After confirming the number of factors in the data, I employed Partial Least Squares (PLS) Structural Equation Modeling (SEM) to determine the relationship between the six determinants (from HBM) and health behaviour for each gamer type. PLS is especially recommended for theory formation and verification [86]. Moreover, PLS-Structural Equation Modeling has less stringent requirements concerning data distribution assumptions [86] and can accommodate small sample sizes as opposed to covariance-based SEM. In the CFA, the six factors were included as latent (independent) variables, and each was hypothesized to have a direct influence on health behaviour – the dependent variable.

3.4.2 Multi-Group Comparison

Prior to comparing the models, I 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 groups had similar interpretations of the instrument's items. Failure to establish measurement invariance would suggest that I measured different phenomena across the groups, therefore making comparison between groups meaningless [164]. To assess measurement invariance, I used the component-based CFA in SmartPLS 2 [157] to conduct factor analysis for each group of data (each gamer type), and retained items that had factor loadings of at least 0.5 [80] in all the groups (and dropped for all groups items with loadings less than 0.5), thereby establishing configural invariance. After configural invariance was established, I also assessed and established metric (equivalent factor loadings) and scalar invariance (equivalent intercepts) by first running bootstrap analyses using a resample size of 1000, and generating the standard error (SE) for each item weight in each group. Next, I ran the PLS algorithm for each group and recorded the actual weight. I calculated t-statistics and corresponding p-values to see if there were significant differences across the groups (at $p < .05$) using the weight, SE, and sample size in each group. Items that were significantly different were dropped for all groups. I repeated this analysis until the results were stable, and I repeated the same process for indicator loadings. I also examined latent score differences across groups. This process established measurement invariance and ensured that the data were suitable for multi-group comparison.

I report here the common set of indices recommended for model validity and reliability in PLS. I used SmartPLS 2 [157] to analyze the model. Indicator reliability can be assumed because Cronbach's α and the composite reliability that analyze the strength of each indicator's correlation with their variables are all higher than their threshold value of 0.7 [38]. 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 [38]. The measurement models yielded an acceptable value of all indices for PLS model validity or reliability.

3.4.3 Moderating Effect

A proper comparison of the models cannot be achieved without establishing that the models' estimates are significantly different. To access for significant structural differences between the gamer types, I used the pairwise comparison approach recommended by Chin [39]. Specifically, I used the PLS algorithm in SmartPLS 2 to separately estimate path coefficients (β) for each group. Then, I used bootstrap resampling technique to calculate standard error (SE) for each path. With the β, SE, and the sample size, I calculated t-statistics and the corresponding p-value to test for significant differences between path estimates of different gamer types. I controlled for familywise type I error (due to multiple comparisons) using Bonferroni adjustment. Our result shows that only 39 of the 126 pairwise comparisons were not significantly different. This high percentage of significant differences shows the moderating effect of gamer type.

3.5 Results and Interpretation

To examine the differences in the interactions between the six determinants and the outcome of health behaviour, I developed seven models (one for each gamer type).

3.5.1 The Structural Model

The structural models determine the relationship between the determinants and health behaviour. 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) [80]. Path coefficients measure the influence of a variable on another. The individual path coefficients and their corresponding level of significance obtained from the seven models are summarized in Table 3.1.

Table 3.1: Standardized path coefficients and significance of the models. Bolded coefficients have p<.001, non-bolded have p<.05 and '-' represents non-significant coefficients

Factors	SUS	SEV	BEN	BAR	CUA	EFF
Achiever	**.44**	-.24	-.30	**-.39**	**.31**	.26
Conqueror	-	-	**.48**	**-.38**	**.58**	-
Daredevil	.20	-.36	**.35**	-	**-.46**	-
Mastermind	-	**.35**	-	**-.29**	**.35**	.37
Seeker	-.17	-	.25	-	.37	.24
Socializer	.15	-	.17	-.31	.25	.22
Survivor	-.15	-	**.35**	**-.36**	-	-
SUS = perceived susceptibility, SEV = perceived severity, BEN = perceived benefit, BAR = perceived barrier, CUA = cue to action, EFF = self-efficacy						

3.5.2 Comparison of Health Behaviour Determinants for the Seven Gamer Types

The results from the models show that the seven gamer types (*achiever, conqueror, daredevil, seeker, socializer,* and *survivor*) differ with regards to the influence of the determinants (SUS, SEV, BEN, BAR, CUA, and EFF) on their likelihood of adopting healthy behaviour (see Table 3.1). We discuss and compare the influence of the determinants on the gamer types in the following sections.

3.5.2.1 Perceived Susceptibility

HBM proposed that increasing an individual's perceived risk (susceptibility) associated with a particular health behaviour could be an effective way of motivating health behaviour change. Surprisingly, the results from the model show however that risk perception is only an important motivator of behaviour change for *achievers, daredevils,* and *socializers*. In fact, designing a persuasive game to increase the perceived risk associated with a health behaviour has no effect on the likelihood of behaviour for *conquerors* and *masterminds* and can actually ***deter*** *seekers,* and *survivors* from performing the healthy behaviour. The potential risks associated with unhealthy behaviours is illness and in the extreme case, death. *Susceptibility* can be seen as a potential loss of a healthy and disease-free life. This is often modeled as loss of objects or materials possession of value (disincentive) in games [77], with the hope that players will be motivated to perform health-related behaviour to reduce or avoid the associated risk. The use of this loss-framed mechanic has been questioned, and research has therefore examined the effects of potential loss or gain framing on an individual's motivation, finding that some people are more motivated by loss-framed information while others are motivated by gain-framed information [166]. Our results agree, and define these differences further by suggesting that *achievers, daredevils,* and *socializers* care about what they stand to lose (loss avoidance) while *conquerors, seekers,* and *survivors* care more about what they stand to gain in relation to health behaviour (as can be seen from their interaction with *perceived benefit* in Table 3.1).

3.5.2.2 Perceived Severity

HBM theorized that the perceived seriousness (*severity*) of the consequences of developing a health condition could positively influence an individual's behaviour. From the results of the model, *severity* is in fact a significant positive motivator of health behaviour for *masterminds* only. This is in line with their gaming style of making sound decisions. However, increasing the perceived consequences of unhealthy behaviours can ***demotivate*** *achievers* and *daredevils* from changing the unhealthy behaviour and adopting the healthy alternative. This result is in line with previous research that found *severity* as a weak predictor that might even lead to behaviour avoidance [13]. This is probably because increasing the magnitude of the perceived consequences associated with unhealthy behaviour might make it appear unreal and uncontrollable to *achiever* and *daredevil*. They seem to care more about the perceived risk and not the magnitude of that risk (perhaps the *achiever* sees the outcome as out of reach, whereas the *daredevil* laughs in the face of danger). Similarly, the effect of perceived severity is not significant for *conqueror, seeker, socializer,* and *survivor*. Therefore, portraying the consequences of unhealthy behaviour might not necessarily increase the chances that they will change their behaviour.

3.5.2.3 Perceived Benefit

Surprisingly, *perceived benefit* is a differentiator between *achiever* and other gamer types. As proposed by HBM, *benefit* influences the likelihood of health behaviour performance positively for *conquerors*, *daredevils*, *seekers*, *socializers*, and *survivors*. However, *benefit* has no significant impact on *masterminds,* whereas it influences *achievers* negatively. The negative association of benefit with achievers contradicts the HBM prediction [158]; however, it supports some other findings that *benefit* does not statistically influence the likelihood of healthy eating [51]. A possible explanation is that adopting a healthy behaviour is a lifestyle that spans over a lifetime with no quantifiable benefit. An *achiever* – although goal oriented and motivated by long-term achievement – is more focused on completing tasks and collecting something (e.g., points). Therefore, they are demotivated from performing tasks that have no foreseeable date of completion and collection of accrued benefits. Breaking health behaviour into intermediate goals with intermediate and quantifiable benefits might better motivate achievers.

3.5.2.4 Perceived Barrier

As expected, *barrier* significantly influences all the gamer types negatively, with the exception of *daredevils* and *seekers* who do not show significant reactions to perceived barriers but are significantly motivated by benefit. Therefore, creating successful persuasive games targeting *daredevils* and *seekers* will likely require designers to increase the perceived benefit more than lowering the cost (barrier) of adopting the healthy behaviour. People usually weigh the benefit and cost to decide on their line of action.

3.5.2.5 Cue to Action

Cue to action – which can be thought of as any event or stimuli that triggers the performance of a target behaviour – is positively associated with health behaviour for all gamer types except for *survivors* (not significant) and *daredevils* (negative association). This implies that extensive use of various cues to action (e.g., prompts, reminders, alerts, biofeedback) will be effective at motivating health behaviour performance for most gamer types. The negative influence of cue to action on the daredevil's likelihood of health behaviour is the major differentiator between daredevils and other gamer types. One possible explanation is that daredevils are thrill seekers and are not interested in reminders to maintain good behaviour.

3.5.2.6 Self-efficacy

As expected, *self-efficacy* is the only determinant that does not influence any gamer type negatively. However, its influence is only significant for *achievers, masterminds, seekers,* and *socializers*. This implies that designing to increase an individual's confidence in his or her ability to perform the health behaviour will motivate a positive behaviour change for most gamers, while not harming others. Persuasive game designers should therefore use various mechanisms (e.g., feedback, graded tasks, incremental goal setting, rehearsal) to promote self-efficacy.

3.5.3 Summary

Table 3.2 shows a summary of the determinants that could be manipulated to effect positive change for each gamer type.

Table 3.2: Summary of significant motivators (persuasive profile) of health behaviour adoption. '√' represents determinants that influence likelihood of health behaviour positively and should be emphasized for each gamer type.

Factors	SUS	SEV	BEN	BAR	CUA	EFF
Achiever	√				√	√
Conqueror			√		√	
Daredevil	√		√			
Mastermind		√			√	√
Seeker			√		√	√
Socializer	√		√		√	√
Survivor			√			
SUS = perceived susceptibility, SEV = perceived severity, BEN = perceived benefit, BAR = perceived barrier, CUA = cue to action, EFF = self-efficacy						

3.6 Discussion

Within this section, I first present two approaches – model-driven one-size-fits approach and model-driven personalized approach – for applying the model results to persuasive game design. I then describe a process that designers can follow to apply health theories to their persuasive game design. Finally, I describe the limitations of the study and opportunities for future work.

3.6.1 Game Mechanics and HBM

Based on an analysis of related work on game mechanics, I identify a number of ways in which the HBM can be integrated into games by mapping the six determinants (SUS, SEV, BEN, BAR, CUA, and EFF) to common game design mechanics. Because there is no definitive list of mechanics and categories, four judges together executed an affinity mapping exercise on existing lists of game mechanics (e.g., [202,203]), resulting in the 7 categories of mechanics shown in **Error! Reference source not found.**. They then mapped the mechanics to the determinant(s) that best matched. For example, for the mechanic quest, within the category game elements, they chose *cue to action* and *barrier*. Quests are tasks that players must complete, providing both guidance on what to do next (CUA) and limits to progression in the game (BAR).

3.6.2 Model-driven "One Size Fits All" Persuasive Game Design

Although the results from the models show that it is necessary to tailor persuasive games to various gamer types (using appropriate determinant(s) that are positively associated with behaviour change for each gamer type), it also shows that some determinants are perceived as positive by majority of the gamer types. Therefore, these determinants could be manipulated to design for a broader audience. I discuss how the findings can be applied to the design of persuasive health games for the broadest audience, to appeal to the majority of players.

The results show that *self-efficacy* is perceived as positive by *achievers*, *masterminds*, *seekers* and *socializers,* and does not negatively impact other gamer types. Therefore, to appeal to a broad group of players, persuasive game designers should ***include game elements that address self-efficacy***. For example, the player-related mechanics of ownership, loyalty, and pride relate to self-efficacy, while the game elements of repeating simple actions and cascading information will build self-efficacy within the context of playing the game. Urgent optimism should be an effective approach, as long as the game can create in players the belief that they will succeed.

The determinants of *cues to action* and *perceived benefits* only have a negative relationship with one gamer type each. Given the even distribution of gamer types, including these two determinants in persuasive games for broad audiences would only have potential negative effects on a small group of players, while being beneficial for the majority of users. Therefore, games designers could ***include mechanics that support cues to action and demonstrate the benefits of behaviour change to appeal to a majority of the population***. For example, most reward-based mechanics (e.g., levels, points) can reinforce the benefits of healthy behaviour, while behavioural momentum and blissful productivity are in line with the positive message of *perceived benefit*. Mechanics that structure play (e.g., quests, appointments, and cascading information theory) give players an idea of how to change their behaviour in stages and with reminders (*cue to action*).

Our results showed that *perceived barriers* have a negative impact on most gamer types, and no effect on *daredevils* or *seekers*; no gamer type was motivated by *perceived barrier*. Therefore, game designers should ***avoid game elements that emphasize the barriers to the adoption of healthy behaviour*** but could use mechanics that help build up confidence or skills for overcoming such barriers There are several game mechanics from the list (in **Error! Reference source not found.**) that should be avoided or applied very carefully. Disincentives and extinction of rewards are two mechanics that might not be effective with any gamer type. This is in line with recent work showing how negative reinforcements might not be as effective for behaviour change as positive reinforcements [50]. In addition, some mechanics have to be carefully applied to avoid reinforcing barriers. For example, quests, which support cue to action (and are thus desirable), must not present so many barriers that the player is demotivated.

It is important to emphasize that even the model-driven one-size-fits all approach (although better than the design-by-intuition one-size fits all approach that is based on guesswork) is not an optimal approach. However, its presents a compromise between the cost of maximizing the effectiveness of persuasive games by tailoring them to the gamer types and employing a uniform determinant that will be effective for the majority of gamer types. As shown in Table 3.1, even the best one-size-fits all determinant of self-efficacy is only positively and significantly associated with four out of the seven gamer types – not significant for three gamer types. This therefore reinforces the need to tailor persuasive games.

Table 3.3: 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 behaviour change
	Loss aversion	Not punishing player as long as the desired behaviour is shown (but not
	Bonuses	In-game reward for overcoming challenges to reinforce desired behaviour, e.g. combos
Behaviour	Behavioural contrast	Irrational player behaviour
	Blissful productivity	Players work hard within game if actions are meaningful
	Behavioural	Players keep going because they feel what they are 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
	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

3.6.3 Model-driven Personalized Persuasive Game Design Approach

Although designing for the broadest possible audience is often desired by designers, as can be seen from the models (Table 3.1), there are situations in which personalizing game experience for a particular gamer type or game genre is necessary.

For example, consider a designer tasked with building a voluntarily-played Massively MultiplayerOnline Role-playing Game (MMORPG) to persuade healthy behaviour change. MMORPG games are most enjoyed by the *achiever* and *socializer* types [201] and less by remaining types. Although mechanics related to *cue to action* and *self-efficacy* can be applied to these two gamer types, as noted in the previous section, *achievers* and *socializers* are both positively incentivized by *susceptibility*. Because we can assume that a large proportion of the MMORPG players will fall into one of these two types [137], ***it is appropriate to use mechanics related to susceptibility when designing MMORPGs***. Thus, mechanics such as loss aversion and countdown could be applied in this context.

Consider also the *mastermind*, who enjoys solving puzzles and devising strategies [137] – there are specific types of games that are based on strategic problem solving. *Mastermind* is the only gamer type positively influenced by *severity*, so ***games personalized for masterminds can effectively use mechanics that promote severity***. For example, the negative reward of disincentives, loss aversion, and extinction could work well for this gamer type.

This last example demonstrates how persuasive games can personalize for a particular gamer type by using the results of the model and affinity mapping exercise; personalizing design for a specific gamer type is accomplished by following Table 3.2. The MMORPG example shows how persuasive games could be personalized for a particular game genre, by using the results alongside the established links between the kinds of games enjoyed by each gamer type [201]. There are myriad ways in which persuasive games could be personalized based on the results, and I have included two examples here to demonstrate the relationship between the findings and the corresponding game mechanics.

3.7 Applying Health Theories to Persuasive Game Design

Like other PTs, persuasive games for health aim to change behaviour. Therefore, researchers have advocated the use of health theories (which mostly originate from psychology) to inform the design and evaluation of persuasive games. However, many game designers may not have the background to effectively interpret and apply theories in their design. My work can close this gap by translating the psychology of health behaviour to familiar and actionable game mechanics and design approaches.

The models not only provide persuasive profiles (a list of motivators for the gamer types), they could also be used to guide evaluation of such determinants in persuasive games. For example, if a game aims to evaluate the effect of *perceived benefit* in motivating health behaviour, it might be necessary to eliminate all other game mechanics that do not reflect benefit. Considering the mapping of health determinants to game mechanics will be useful in deciding the game components to include and evaluate. Moreover, with the help of the models, persuasive game designers can easily evaluate and interpret the effectiveness of their games with respect to the underlying theoretical determinants being manipulated.

In this chapter, I have demonstrated the need to make specific considerations when designing persuasive games to motivate health behaviour. We now highlight five stages that could be followed to design theory and model-driven persuasive games that are tailored to various gamer groups.

Step 1: Identify the Behaviour

This first step towards designing persuasive games to motivate health behaviour is to identify the target behaviour that needs to be promoted (e.g., healthy eating). This is based on the assumption that some of the game design mechanics and decisions might be domain specific.

Step 2: Determine the Gamer Groups

The second 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 [201] to determine the majority classes that enjoy that genre.

Step 3*: Identify Behaviour Determinants*

The models show that the influence of HBM determinants differs across gamer types; it is necessary for game designers to identify the determinants that motivate behaviour change for each gamer group identified in step 2.

Stage 4: Decide on the Design Approach

After identifying the behaviour determinants in step 3, game designers can adopt a personalized approach or a one-size-fits-all approach, depending on whether the targeted gamer groups (step 2) are influenced by similar determinants.

Step 5: Map Determinants to Game Mechanics

Most of the HBM determinants are not directly implementable. Translating the health determinants into more actionable game mechanics is a necessary step in designing theory-driven persuasive games.

These five steps summarize the steps that game designers can follow to design theory and model-driven approaches to persuasive games, thereby fostering the development of efficacious persuasive games.

3.8 Limitations

There are limitations of applying the results of the model to game design mechanics. First, as noted previously, there is no definitive list of game mechanics; I sourced mechanics from multiple resources, but the list is by no means exhaustive or definitive. Second, I mapped the game mechanics into categories using an affinity mapping exercise. These categories are helpful for distilling the results into actionable lessons; however, the process is subject to interpretation. Third, I apply the results of the models at the level of a population (gamer type). As with all population-based personalization, the results will apply to the majority of the population; however, there may be outliers who do not respond in the predicted manner. Finally, I make the findings actionable by providing examples of how the model results can be incorporated into persuasive game design. This process is not prescriptive of good game design – although the results can provide an advantage in choosing the best persuasive strategy to apply in a persuasive game, applying the findings may not ensure that a game is engaging, motivating, or fun to play.

While this work has benefited from the large-scale study of gamers' eating behaviour, I cannot assume its validity in other health behaviour domains (e.g., physical activity). Therefore, the model should be applied with caution in other health behaviour domains. However, the underlying principle of mapping determinants to game mechanics and tailoring to gamer types can be applied in any health behaviour domain. Although 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 this study) might moderate the impact of the six HBM's determinants on health behaviour.

3.9 Summary

Persuasive games can be effective tools for motivating healthy behaviour change. However, the effectiveness of persuasive games for health may be dependent on manipulating appropriate theoretical determinants for the right audience. As a result, the first step in designing effective health interventions is to identify the determinants that influence behaviour for the target audience to enable tailoring. However, there has been no research on how to tailor health determinants to various gamer types. This has resulted in an increasing adoption of a designed-by-intuition, one-size-fit-all approach to persuasive game design. This work is a step towards providing practical ways of applying and tailoring theoretical determinants of health behaviour in persuasive game design. I conducted a cross validation of the influence of the six determinants identified by HBM on healthy eating and developed seven different models of healthy behaviour (for each gamer type). The models revealed some differences between the seven gamer types, and I discussed these differences from the perspective of health behaviour and persuasive game design. Through this study, I exposed the limitations of the current approaches to persuasive game design, and presented design opportunities for both a model-driven one-size-fit-all and a personalized approach to persuasive game design that is grounded in both theory and data. I argued that for persuasive games for health to achieve their intended objective of changing health behaviour, they must be designed to manipulate the determinants of health behaviour and be tailored in accordance with the models to the gamer type. That the best one-size-fits-all determinants (of self-efficacy) from the models is only capable of influencing significant healthy behaviour change in four out of the seven gamer types, reinforces the need to tailor persuasive games to gamer types using their persuasive profiles to increase their efficacy.

3.10 Contributions of the Work Presented in this Chapter

The main contributions of this chapter are as follows: First, I conducted a cross validation of the influence of the determinants identified by HBM on healthy eating and developed seven different models of healthy behaviour (one for each gamer type). Second, I discussed the differences between the seven gamer types from the perspective of health behaviour determinants and persuasive game design. Third, I proposed model-driven design approaches for developing persuasive game interventions for motivating healthy eating. Fourth, I produced persuasive profiles (comprised of a list of motivators of health behaviour). The persuasive profiles will serve as guidelines for tailoring persuasive games to the individual gamer types identified by BrainHex to make them personalized for each gamer type. Finally, one of the constraints with many theoretical driven frameworks for intervention development is their abstract nature – there is little information on how the theoretical determinants can be translated into system design. Therefore, to make the guidelines actionable in persuasive game intervention design, I compiled a list of common game design mechanics and mapped theoretical determinants to appropriate game design mechanics.

To the best of my knowledge, this study is the first to link research on the psychology of player typologies (as identified by BrainHex) with the psychology of health behaviour change (as identified by HBM) to find patterns in gamers' motivation that can inform the choice of game mechanics for designing games that will motivate behaviour change. It is also the first to suggest model-driven and gamer type-relevant game design approaches that are actionable for designers and developers of persuasive games for motivating health behaviour. The research shows that having a personalized persuasive profile of what motivates different gamer types, and mapping these theoretical motivators to game mechanics, provides a crucial theoretical and methodological bridge between research on what motivates health behaviour change (i.e., theories) and research on designing games for health (i.e., persuasive games).

CHAPTER 4

MODELLING THE EFFICACY OF PERSUASIVE STRATEGIES FOR PERSUASIVE GAMES FOR HEALTH

The previous chapter has shown that large differences exist between the gamer types with respect to the influence of the determinants identified by HBM on their likelihood of adopting healthy behaviour. Therefore, it is inappropriate for persuasive game designers to treat players as a monolithic group by adopting the one-size-fits-all approach in their choice of theoretical determinants to inform their game design. As a solution to this, I developed models and persuasive profiles which serve as guidelines for tailoring determinants to various gamer types. The research contributes to the first step of Persuasive Technology (PT) development, according to the framework by Michie et al. [134] – identifying behavioural determinants, Section 2.4. However, the first step which deals with identifying the behavioural determinant could be optional in PT design. In some cases, especially when the determinants influencing the target behaviour are already known, designers start their persuasive game design from step 2 – identifying strategies (which can easily be translated to a game design features). Nevertheless, even in such cases, designers still need to identify the appropriateness of various strategies for the target audience. This is because more than one strategy can be employed to influence change in a single determinant [134] and in the literature, there is no clear mapping between determinants and strategies.

Consequently, as discussed in Section 2.4, another way that persuasive games can be tailored is to tailor the persuasive strategies employed in the game design. Therefore, effective tailoring of persuasive games also entails tailoring the persuasive strategies employed in persuasive game design. Hence, this chapter moves a step further from the theories and determinants to investigate whether differences between the gamer types exist in their response to various persuasive strategies. Specifically, I present a large-scale study investigating the effectiveness of commonly used strategies in persuasive game design. To investigate for possible differences across and between the gamer types with respect to their response to various strategies, I develop models showing the persuasiveness of ten commonly used strategies, and propose design guidelines – based on the models – for tailoring PT interventions to various gamer personalities commonly referred to as gamer types. The design guidelines are based on a quantitative study of 1108 gamers, where I studied the persuasiveness of the strategies (*customization, simulation, self-monitoring and feedback, suggestion, personalization, simulation, praise, reward, comparison, competition,* and *cooperation*) identified by Oinas-Kukkonen [139] and Fogg [62] on gamers of seven types (*achiever, conqueror, daredevil, mastermind, seeker, socializer,* and *survivor*) identified by the BrainHex model [19]. The models reveal several differences and some similarities in the persuasiveness of various strategies with respect to their influence on the gamer types. Based on the results of the models, I highlight the best and the worst strategies for designing persuasive games that target each gamer type. Finally, I propose two model-driven approaches for designing persuasive games: a '*one-size-fits-all*' approach that will appeal to the majority of gamers, and a *personalized* approach that tailors persuasive games for health behaviour to gamer personality. To make the findings more actionable, I conclude this chapter by suggesting mappings of persuasive strategies to common game mechanics that can be employed in persuasive game design.

4.1 Persuasive Strategies

Persuasive strategies are techniques that can be employed in PT to motivate behaviour and/or attitude change. Over the years, a number of persuasive strategies have been developed. For instance, Cialdini [40] developed six persuasive principles, Fogg [62] developed seven persuasive tools, and Oinas-Kukkonen [139] built on Fogg's strategies to develop 28 persuasive system design principles. These strategies are often applied in combinations when incorporated in an actual persuasive system [83]. The choice and the suitability of the strategies for a particular user or user group are often based on the 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 explored simultaneously in a study, in this dissertation, I 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 [122,194].

- *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 behaviour. It is one of the rarely employed strategies in health game design.
- *Self-monitoring* (also called *Feedback*) allows people to track their own behaviours, providing information on both past and current states. It is one of the most common strategies for healthy eating and physical activity motivating applications [29,186].
- *Suggestion* strategy suggests certain tasks (for achieving favourable behaviour outcomes) to users during system use.
- *Praise* applauds the user for performing the target behaviour via words, images, symbols, or sounds as a way to give positive feedback to the user (for example, in [14,183]).
- *Reward* offers virtual rewards to users for performing the target behaviour. It is one of the commonly employed strategies [20,77,145].
- *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 needs based on a user's characteristics.

For a detailed discussion of the strategies, see [139].

4.2 Deconstructing Game-Based Interventions with Emphasis on Strategies Employed

In this subsection, I present a review of persuasive health games in each category with a deconstruction of strategies employed in each game.

4.2.1 Game-Based Interventions for Health Promotion and Strategies Employed

Persuasive games employing several strategies 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 behaviour [97]. 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 [145]. *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 [49]. *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 behaviour 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, *RightWay Café* is a role playing game that employs *customization, competition, simulation, personalization,* and *suggestion* to promote healthy eating and physical activity [149]. 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 [97]. 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 [103], 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.

4.2.2 Game-Based Interventions for Disease Management and Strategies Employed

Similarly, games employing several strategies 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 behaviour, and providing opportunities for players to rehearse health behaviours in relation to a specific health condition/illness [106]. 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 task is to keep their characters' diabetes under control by monitoring blood sugar, providing insulin, and managing food and other related illnesses [31]. 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 behaviour 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 [127]. 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 to 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 decisions 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 [189]. 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 behaviours, 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 behaviour and motivation [37,143,196]. 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 [97].

4.3 Tailoring Persuasive Strategies to Users and User Groups

People differ in motivation and belief about health and what constitutes a healthy life [143]. Kaptein et al. [103] 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 behaviour 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. Khaled et al. [53] 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 and Kientz [81] 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) [73] captured important characteristics for tailoring strategies to better fit the needs of the users [81]. Similarly, Hirsh et al. [88] 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 [73] was an effective way of increasing the impact of the message on the recipient. Along these lines, Arteaga et al. [11] 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 type. 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 [10]. Although several persuasive researchers have adopted the FFM to tailor their applications, the adequacy of FFM for tailoring persuasive games has been questioned [18]. Therefore, researchers have focused on alternative approaches for tailoring persuasive games. For example, Tan et al. [177] 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!* [24]. To minimize the variability in the perceived enjoyment and amount of activities performed by novice and experienced 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.

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 dissertation, I focus on game-based persuasive interventions. According to Berkovsky et al. [25], 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 [19]. The work reported in Chapter 3 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 the strategies to various gamer types.

In summary, the review of related work shows that persuasive games have gained popularity as an innovative approach for motivating change in health behaviour. 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 chapter, with the aim of developing guidelines for tailoring strategies to the seven gamer types (*achiever, conqueror, daredevil, mastermind, seeker, socializer,* and *survivor*) identified by BrianHex, I investigate and compare the persuasiveness of ten commonly employed strategies.

4.4 Study Design and Methods

The 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 behaviour (specifically, healthy eating) for the seven gamer types – Achiever, Conqueror, Daredevil, Mastermind, Seeker, Socializer, and Survivor. In this section, I first describe how I developed the research instrument; this is followed by discussion of the data collection methods and validation.

4.4.1 Measurement Instrument

To collect data for the model, I followed the approach described by Halko and Kientz [81]. Specifically, I represented each persuasive strategy in a storyboard about a persuasive game for motivating healthy eating. The storyboards show a character and his/her interactions with a persuasive game application for promoting healthy eating. Figure 4.1 shows examples of two of the ten used persuasive strategies, reward and personalization; the remaining storyboards are included in the appendix. The ten storyboards were drawn by an artist and were based on storyboard design guidelines by Truong et al. [185]. Although the individual strategies could be implemented and their suitability evaluated in applications, I 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 [123]. Second, it is easier to collect a large volume of data needed for building and validating my 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 [81]. 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 one to show in an "ideal" form the essence of persuasive interaction.

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. [55]. 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". I also included an open-ended question allowing participants to provide comments about each strategy. Prior to assessing the persuasiveness of the various strategies, I 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, I also retained responses from participants who answered one of the comprehension questions correctly. I also included 28 BrainHex questions to classify the participants into various gamer types; questions for assessing the participants' demographic information, and eating behaviour were also included. The detailed instrument used for the study is included in the appendix.

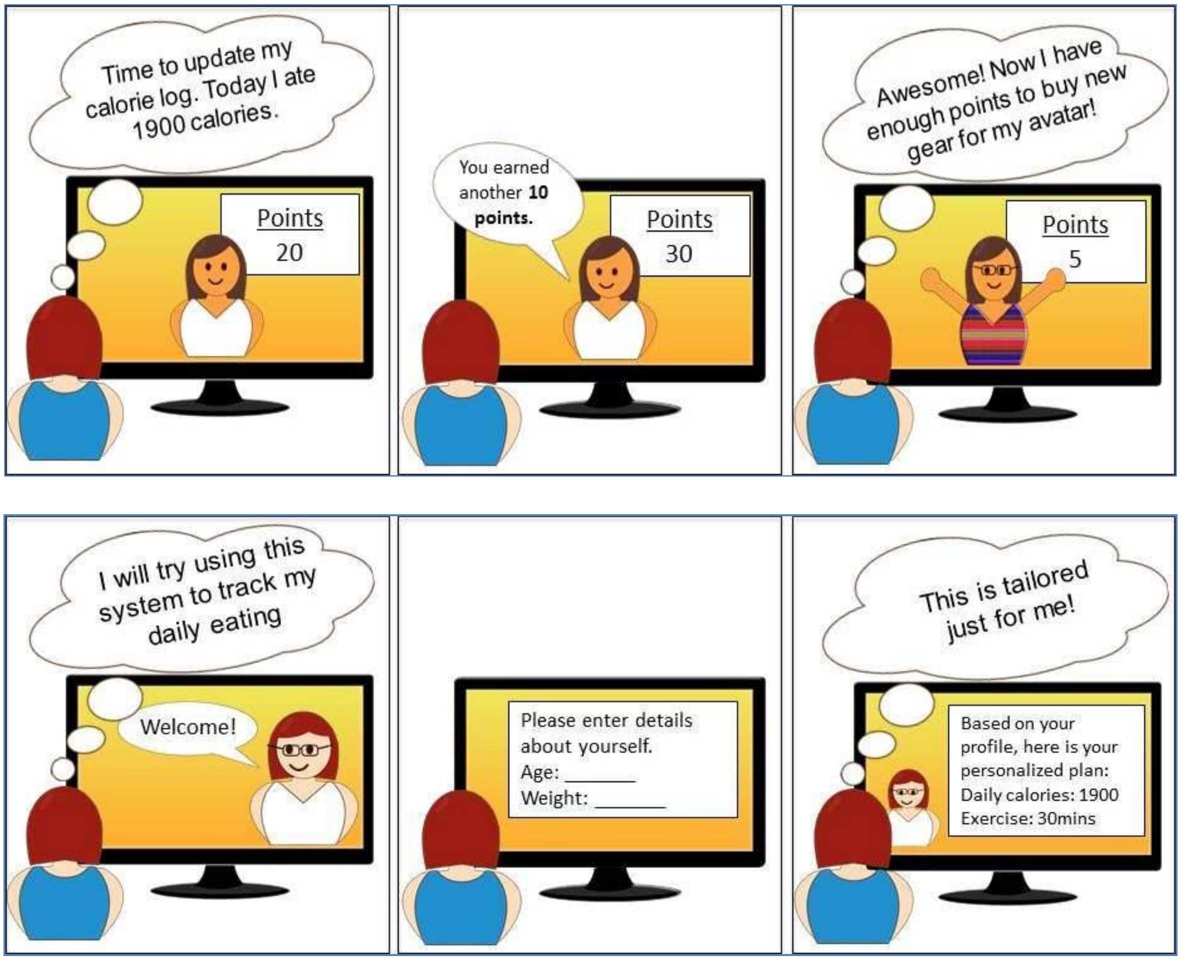


Figure 4.1: Storyboard illustrating reward (top) and personalization (bottom) strategy

4.4.2 Data Collection and Filtering

I recruited participants for this study using Amazon's Mechanical Turk (AMT). I used AMT for two main reasons – first, AMT has become an accepted method of gathering users' responses [32,81,85,88,125,131]; and second, I needed a large participant sample and diverse audience for the study. AMT allows access to a global audience at a relatively low cost, and ensures efficient survey distribution, and high quality results [32,131]. I followed the recommendations for performing effective studies on AMT by Mason and Suri [131], and used a similar approach to the one described by Halko and Kientz [81] to overcome potential problems associated with recruiting from AMT, such as the issue of mechanical bots completing a survey. Specifically, I used captcha to ensure that only human participants are retained in the survey. I ensured that participants could respond to the study only once using a mechanism provided by AMT that allows collection of response from unique participants. I 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), I also included time stamps to ensure that participants did not game the study by completing it without reading or understanding. I tracked the total time taken by participants to complete the survey. The study took an average of 30 minutes to complete. The responses from participants who completed before a threshold time – 20 minutes – were discarded. Furthermore, I employed attention questions to ensure that participants were actively considering their answers. Specifically, I 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. I collected a total of 1384 responses and retained a total of 1108 valid responses, which were included in the analysis.

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

Before the main study, I conducted two pilot studies. The first pilot study was conducted on 30 participants (15 participants from AMT and 15 participants recruited from the University of Saskatchewan) to test the validity of the 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. I 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 the study instrument by showing that participants understood the storyboards, react differently to the strategies, and was able to complete the study with ease.

4.4.3 Participants' Demographic Information

A total of 1384 participants responded to the study and their demographic information is summarized in Table 4.1. The participants received $1 USD dollar compensation, which is within the range of the standard rates for other tasks recruited through AMT. In general, I have a relatively diverse population in terms of gender, age, education level attained, and gamer types. Half of the participants play games every day and over 60% of the participants are from the United States.

Table 4.1: Participants' demographic information

Total Participants = 1108	
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%)

4.4.4 Data Analysis

The main aim of this chapter 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, I used several well-known analytical tools and procedures. In this section, I summarize the various steps taken to analyse the data.

1. I validated that the storyboards correctly depicted the intended strategy using a chi-squared test [81].
2. I determined the suitability of the data for factor analysis using the Kaiser-Meyer-Olkin (KMO) sampling adequacies and the Bartlett Test of Sphericity [99]. Given these positive results, I determined that the data was suitable to conduct factor analysis [87,103].
3. Because the individual strategies have not been validated together before, I performed Exploratory Factor Analysis (EFA) to determine the number of factors available in the study [46].
4. After I established the number of factors available, I employed the Partial Least Square (PLS) Structural Equation Modeling (SEM) [157] 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, I performed multi-group comparison using the pairwise approach recommended by Chin [39]. Specifically, I examined the models for significant differences across the seven groups.
6. I employed the Bonferroni-Holm adjustment to control any familywise Type 1 error due to multiple comparisons [91]. 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, I describe how the participants were classified into discrete gamer types, using the dominant BrainHex class [201]. Detailed information on each of these steps in the analysis process is provided in the following subsections; this is followed by the results of the modeling process.

The details of the analysis process is similar to that used in Chapter 3, readers familiar with this process can skip ahead with the results of the modeling process and interpretation described in Section 4.5.

4.4.5 Storyboard Validation

To ensure that participants understood the intended strategy in each of the storyboards, I 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 [81].

I discarded incorrect responses before running the chi-squared tests because I 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 I added the 27 responses discarded, the chi-squared result would still be significant (at 0.05 in the worst case scenario).

4.4.6 Measurement Validation

I determined the suitability of the data for factor analysis using the Kaiser-Meyer-Olkin (KMO) sampling adequacies and the Bartlett Test of Sphericity. The 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 (χ^2 (780) = 67805.9, $p<0.0001$); and that all of the communalities were well above 0.3. These results show that the data were suitable for factor analysis [39, 45].

To determine the appropriate number of factors in the data, I performed Exploratory Factor Analysis (EFA) – a statistical procedure that identifies the number of latent factors in a set of variables – using Principal Component Analysis (PCA). I first examined the eigenvalue against the component number and considered factors with an eigenvalue of at least 1 [98]. As shown in Figure 4.2 and Table 4.2, 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. I further examined the eight-factor solution using Oblimin rotation [30]. Table 4.3 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 the 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 minimum loading because it indicates that the factor explained at least 10% of the variance in the corresponding variable [181]. 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 the participants perceived these strategies as being similar. I further discuss these two groupings in the results section. Consequently, I 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. I present the description of each of the factors extracted from the PCA in Table 4.4.

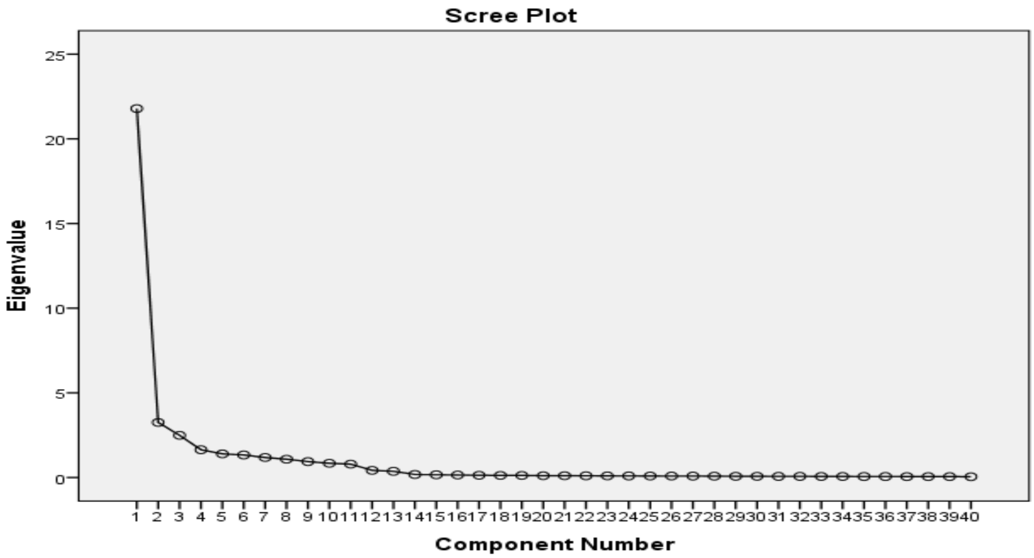


Figure 4.2: Scree plot showing eigenvalues (y-axis) of each of the extracted components (x-axis)

Table 4.2: Eigenvalue and total variance explained – factors with Eigenvalue less than 1 have been removed

Component	Initial Eigenvalues ≥ 1			Rotation Sums of Squared Loadi
	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 4.3: Factor loadings based on principal component analysis with Oblimin rotation of the 40 Items measuring persuasiveness of the 10 strategies. Comp = Components

	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

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

Table 4.4: 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&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&Suggestion	8	4.31 (1.59)	.958
Simulation	4	4.62 (1.73)	.964

4.4.7 The Measurement Model

After determining the number of factors in the data using PCA, I employed the Partial Least Square (PLS) Structural Equation Modeling (SEM) to develop models showing the persuasiveness of the ten strategies for various gamer types. SEM is a recommended approach for modeling of relationships between variables [120] and it has been successfully used in building models and estimating relationships between various personality types and several technological and behavioural factors (e.g., see [57,88,141]). PLS is a prediction-oriented approach to SEM that has less stringent requirements concerning data distribution assumptions [86]. It can accommodate small sample sizes, as opposed to covariance-based SEM. I chose PLS over a covariant-based approach (e.g., LISREL) because it is highly appropriate for complex predictive models [15]. Specifically, I used SmartPLS 2.0 (M3) [157] in estimating my models. I argue that PLS-SEM is the most appropriate statistical technique to utilize in this research, because the constructs in this research model have not been tested together.

As recommended by Anderson and Gerbing [7], I validated the measurement model before estimating the structural paths to test for the relationship between the variables using the criteria suggested by Chin [38]. PLS-SEM assesses the property of scales in terms of convergent validity, discriminate validity, and composite reliability. I report here the common set of indices recommended for model validity and reliability in PLS. Using criteria from Chin [38] and Fornell and Larcker [64], indicator reliability can be assumed because Cronbach's α – see Table 4.4 – 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 [38,64]. The measurement models yielded an acceptable value of all indices for PLS model validity and reliability.

Prior to comparing my models, I 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 the instrument's items. A failure to establish measurement invariance would suggest that I have measured different phenomena across the sub-groups, and therefore makes comparison between sub-groups using the data not worthwhile [164]. To assess measurement invariance, I used the Component-based Factor Analysis (CFA) in SmartPLS 2.0 (M3) [157] to conduct factor analysis for each sub-group of data and retained items that had factor loadings of at least 0.5 [80] 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, I also assessed and established metric (equivalent factor loadings) and scalar invariance (equivalent intercepts) by first running bootstrap analyses using a resample size of 1000, and generating the standard error (SE) for each item's weight in each sub-group. Next, I ran the PLS algorithm for each sub-group and recorded the actual weight. I 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 the data were suitable for multi-group comparison [164,169].

4.4.8 Gamer Type Reliable Characteristics for Tailoring

To examine the differences and similarity in the perception of the ten strategies by the seven gamer types, I separately modeled the efficacy of each strategy for each gamer type. Gamer type was chosen through the BrainHex method [201], which yields a score for each of the seven types for each individual. By choosing the dominant type, I 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 the dominant type from the study.

To establish that gamer type is a reliable characteristic for tailoring persuasive games, I assessed for significant structural differences between the models for each gamer types using the pairwise comparison approach recommended by Chin [39]. Specifically, I used the PLS algorithm in SmartPLS to separately estimate the path coefficient (β) for each group. Then, I used the bootstrap resampling technique to calculate standard error (SE) for each structural path. With the β, SE, and the sample size, I 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, I controlled for any possible familywise type I error (due to multiple comparisons) using the Bonferroni-Holm adjustment. I found significant differences across the gamer types; therefore, I establish that gamer type is a reliable characteristic for tailoring persuasive games.

4.5 Results and Interpretation

In this section, I present the results of the structural models and interpret the findings. As noted previously, I 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. I further discuss the findings in the general discussion.

4.5.1 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) [80]. Path coefficients measure the influence of a variable on another. The individual path coefficients (β) and their corresponding level of significance (p) obtained from the models are summarized in Table 4.5.

Table 4.5: Standardized path coefficients (β). All displayed coefficients are significant at p< .05, whereas '-' represents non-significant coefficients. The negative coefficients are highlighted.

Strategies / Gamer Type	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

CMPT/CMPR = competition and comparison, COOP = cooperation, CUST = customization, PERS = personalization, PRAS = praise, SEMT/SUGG = self-monitoring and suggestion, SIML = simulation, REWD = reward.

4.5.2 Persuasiveness of the Strategies for the Seven Gamer Types

The results from the 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 4.5. In this section, I discuss and compare the perceptions of strategies by the gamer types.

4.5.2.1 Competition and Comparison

Competition and comparison are among the commonly used strategies in PT intervention design in general and in persuasive games design specifically (for e.g., see [20,67,126,145]). 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 [78]. 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 acquire higher status in a group [139]. 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) [62]. In line with the general assumptions, the results from the models show that competition and comparison is perceived positively by all gamer types except achiever and daredevil. As shown in Table 4.5, conqueror, mastermind, seeker, socializer, and survivor are significantly positively associated with competition and comparison (β=.25), (β=.12), (β= .10), (β=.11), and (β=.17), respectively. In line with this finding, many participants in the 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 (β=-.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 [201] or recognition that demonstrates their success in the game; this is confirmed by their significant positive association with reward in the 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 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 behaviour performance may in fact have no impact on achievers and can actually deter daredevils from playing the game and hence performing the

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

intended behaviour. The result is in line with previous research that found that users were uncomfortable with using competition to motivate behaviour in a health application [78,183], and may even become demotivated if they lose [20]. For example, during an evaluation of persuasive technology intended to encourage family reflection, participants worried that comparing the health behaviours and measures of different family members could lead to negative comparison and competitiveness [78]. The tendency of competition and comparison to demotivate behaviour for some people is summarized in a statement by Kohn [117], 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*."

4.5.2.2 Cooperation

According to the PSD framework, "a system can motivate users to adopt a target attitude or behaviour by leveraging human beings' natural drive to co-operate."[139]. 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, [20]. 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 behaviour performance.

The results from the study show, however, that cooperation is only a significant motivator of behaviour change for achievers and socializers, with (β=.15) and (β=.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 [16] "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 [20].

On the other hand, introducing cooperation demotivates survivors (β=-.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 a 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 [117].

4.5.2.3 Customization and Personalization

Customization and personalization represent two separate strategies in the model, however, I 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 behaviour change in general [138]. 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* [175]. 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 [175]. According to Sundar et al. [174], "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 [175]. Based on these findings, I separated the two types of tailoring – customization and personalization – and studied their persuasiveness. The results from the 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 behaviours. 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 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 [175]. From the result, conquerors belong to the latter group, in that they may be significantly motivated by the relevance of content provided by personalization (β=.12) and care less about control. Similarly, masterminds and seekers are incentivized by both customization (β=.10; β=.19) and personalization (β=.12; β=.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 (β=-.12; β=-.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 [175], which suggests that some users are more comfortable with the default setting, and do not like systems that really get them involved.

4.5.2.4 Praise

Using praise to motivate system usage and behaviour change looks trivial, however, it has been elegantly employed by some PT applications to motivate healthy behaviour change (for example, see [14,183]). 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 behaviour performance via words, images, symbols, and sounds [139]. The results from the 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 (β= .10), while socializers are negatively associated with praise (β=-.12). The negative relationship of socializers with praise is somewhat 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 really perceived as important by achievers, conquerors, daredevils, masterminds, and survivors.

4.5.2.5 Self-monitoring and Suggestion

In literature, self-monitoring and suggestion has been considered as two different strategies [139], but in practice, they are often used together, as they seem to complement and enhance each other. An effective suggestion strategy requires context-awareness [8] or monitoring of both the behaviour and the opportune moment for suggestion. The analysis of the data reveals that self-monitoring and suggestion are viewed similarly by users – they loaded into the same factor. Therefore, I have grouped them together as one variable in the 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 [20,43,67,183,186]). 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 (β=.10), (β=.12), (β= .14), and (β=.27), respectively, while it is perceived as negative by socializer and daredevil, (β=-.14) and (β=-.13), respectively. The negative perception of self-monitoring and suggestion by socializer and daredevil is in line with other research that recorded some negative reactions 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 [29]. 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 diets or editing and correcting erroneous data. Some of the 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.

4.5.2.6 Simulation

According to Fogg [62] an application can persuade people to change their attitude or behaviour if it provides a way for people to observe the immediate cause and effect linkage of their behaviours. Simulation is not among the commonly employed strategies in intervention design for health promotion. Interestingly, from the 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 (β=.14), (β =.11), and (β=.12), respectively. This suggests that a persuasive game that is designed to show users the (future) outcome of their behaviours could motivate them to change. This is particularly necessary for PT interventions aimed at motivating healthy behaviour. Adopting healthy behaviour is a lifestyle that spans over a lifetime, and it does not have immediately visible consequences. Therefore, people tend to be demotivated from adopting a healthy behaviour that has no observable immediate benefit or consequences. Simulating behaviour can close this gap, as it allows users to visualize and compare outcomes of alternative behaviours 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 behaviour 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 behaviours.

4.5.2.7 Reward

The PSD model states that rewarding target behaviour reinforces the behaviour and may increase the persuasiveness of a system. Therefore, persuasive systems should offer virtual rewards to the user as a credit for performing the target behaviour [139]. As a result, reward is one of the commonly used strategies in applications that motivate health behaviour (for example see, [20,67,126,145,151]). However, from the model, reward emerged as the least significant of the eight strategies. Reward is positively associated with only achiever (β=.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 (β=-.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 behaviour has the potential of redirecting the intention of a particular activity [41]. Similarly, Gneezy and Rustichini [72], 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 behaviour, and the benefit they attribute to it. This is further confirmed by comments from the 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 behaviour – 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 behaviour. Therefore, PT designers should apply some caution when employing any form of reward to motivate health behaviour.

However, it is worth noting, that some studies demonstrated positive effects of incentive mechanisms and showed that change in behaviour can persist after the reinforcement is removed [34]. My findings emphasize the need to tailor the rewards based on the user's susceptibility to and perception of reward.

4.5.3 Results Discussion

In this section, I present heuristics that serve as a guideline for deciding on the appropriate strategies to employ in persuasive game design. Specifically, I 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, I present two approaches for applying the model results to persuasive game design, and map strategies to game design mechanics.

4.5.4 Deciding on the Strategies to Employ for Each Gamer Type

The results summarized in Table 4.5 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 behaviour using the strategies. Based on the results, I present the best strategies to influence health behaviour change and the worst strategies to avoid when designing for each gamer type in Tables 4.6 and 4.7, respectively.

Masterminds are the most easily persuadable of all the gamer types – they are receptive to five strategies (competition and comparison, customization, personalization, self-monitoring and suggestion, and simulation) and are not significantly negatively influenced by any strategy. Masterminds are closely followed by seekers and conquerors, who are both receptive to four out of the eight PT strategies. Seekers are receptive to competition and comparison, customization, personalization, and praise, while conquerors are receptive to competition and comparison, personalization, self-monitoring and suggestion, and simulation. Similarly, seekers and conquerors do not perceive any strategy as significantly negative. Achievers are receptive to three out of the eight strategies – cooperation, reward, self-monitoring and suggestion, and are not negatively associated with any strategy. The least persuadable is daredevil. Daredevils are receptive to only one strategy – simulation – and could be demotivated by games that employ self-monitoring and suggestion or competition and comparison. In the ranking of least persuadable gamer types, daredevil is closely followed by socializer and survivor, who are each receptive to only two strategies and perceive three of the eight strategies as negative. Socializers are receptive to cooperation, competition and comparison and could be demotivated by persuasive games that employ customization, praise, and self-monitoring and suggestion. Similarly, survivors are receptive to self-monitoring&suggestion, competition&comparison. However, employing cooperation, customization, and reward could deter survivors from performing the behaviour.

These results suggest the need for persuasive game designers to take special care not only in deciding on which strategies to employ to motivate behaviour performance for each gamer type, but also which strategies to avoid in order not to deter users from performing the target behaviour. The results from the model can serve as a guide for persuasive game designers to decide on the appropriate strategy to employ for each gamer type. The results are inline with Kaptein et al. [103], who found that a one-size-fits-all approach could be detrimental in health promotion applications. Using inappropriate strategies for a particular user could lead to an increase in unhealthy behaviour, which the intervention in fact aims to discourage.

Table 4.6: Best strategy to achieve high persuasive effect for each gamer type – persuasive profile. Strategies presented in descending order of persuasive strength (underlined is the highest)

Gamer Type	**Best Strategy**
Gamers with high **Achiever** tendency	'<u>Cooperation</u>', 'Reward', 'Self-monitoring and Suggestion'.
Gamers with high **Conqueror** tendency	'<u>Competition and Comparison</u>', 'Simulation', 'Personalization', 'Self-monitoring and Suggestion'.
Gamers with high **Daredevil** tendency	'<u>Simulation</u>'.
Gamers with high **Mastermind** tendency	'<u>Self-monitoring and Suggestion</u>', 'Competition and Comparison', 'Personalization', 'Simulation', 'Customization'
Gamers with high **Seeker** tendency	'<u>Customization</u>', 'Personalization', 'Competition and Comparison', 'Praise'.
Gamers with high **Socializer** tendency	' <u>Cooperation</u>', 'Competition and Comparison'.
Gamers with high **Survivor** tendency	'<u>Self-monitoring and Suggestion</u>', 'Competition and Comparison'.

Table 4.7: Worst strategy for motivating health behaviour for each gamer type – Contra-persuasive profile. Strategies presented in descending order of negative influence.

Gamer Type	**Worst Strategy**
Gamers with high **Achiever** tendency	N/A
Gamers with high **Conqueror** tendency	N/A
Gamers with high **Daredevil** tendency	'<u>Self-monitoring and Suggestion</u>', 'Competition and Comparison'
Gamers with high **Mastermind** tendency	N/A
Gamers with high **Seeker** tendency	N/A
Gamers with high **Socializer** tendency	'<u>Self-monitoring and Suggestion</u>', 'Praise' 'Customization'
Gamers with high **Survivor** tendency	'<u>Cooperation</u>', 'Reward', 'Customization'

4.5.5 Best General Strategies

The results show that some strategies are perceived as persuasive by the majority of the study participants. As can be seen in Table 4.5, competition&comparison, and self-monitoring&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 behaviour 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 4.5, 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 the 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.

4.5.6 Least Efficacious Strategies

The results show that some strategies are not capable of producing the desired results of motivating positive behaviour change in many users. Based on the 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 behaviour performance has been debated in literature [34,72], because the rewards can redirect the intention of a particular activity from being intrinsically to extrinsically motivated [41], and might not produce a long-term behaviour change. However, almost all persuasive games employ rewards to motivate behaviour [20,77,145,151]. Our results showed that reward is not as important as assumed in practical persuasive games, as it can only motivate behaviour 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 behaviour. This implies that persuasive game designers should not use reward and praise as key strategies to influence behaviour 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.

4.6 Mapping Game Mechanics to Persuasive Strategies

Based on an analysis of related work on game mechanics [26,202,203], I 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. I present two approaches for applying the results from the models to persuasive game design – a one-size-fits-all and a personalized approach. To bridge the gap between game designers and persuasive game designers, I mapped the strategies to game mechanics that best matched them. I adapted a list of common game mechanics from Chapter 3, Section 3.6. The list grouped the common game mechanics into seven categories, as shown in **Error! Reference source not found.**. For example, for the strategy cooperation, I chose *communal discovery* and *viral game mechanics* within the social category in **Error! Reference source not found.**. 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 4.8 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 **Error! Reference source not found.** that could be used in representing the eight strategies.

4.6.1 "One Size Fits All" Persuasive Game Design

Although the results from the models show that it is necessary to tailor persuasive games to various gamer types (using appropriate strategies that are positively associated with behaviour change for each gamer type), it also shows that some strategies are perceived as positive by majority the gamer types. Therefore, the results from the models can guide the design of persuasive games using both a one-size-fits-all approach and a personalized approach. I discuss how the findings can be applied to the design of persuasive health games for the broadest audience, to appeal to the majority of players.

The 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 behaviour***. 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 behaviour will impact their lives could be used to create a simulated experience of the real-world behaviour 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.

It is important to emphasize again that even the model-driven one-size-fits all approach (although better than the design-by-intuition one-size fits all approach that is based on guesswork) is not an optimal approach. However, it presents a compromise between the cost of maximizing the effectiveness of persuasive games by tailoring them to the gamer types and employing a uniform strategy that will be effective for the majority of gamer types. As shown in Table 4.5, even the best one-size-fits all simulation and personalization are only positively and significantly associated with three out of the seven gamer types – not significant for four gamer types. This again reinforces the need to tailor persuasive games.

4.6.2 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 [24,25,103]. The results reveal opportunities where personalizing game experience by tailoring strategies for a particular user or user groups is highly desirable. Here, I illustrate with examples how the results from the 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 behaviour change. MMORPG games are mostly enjoyed by the achiever and socializer types [201] 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 behaviour. 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 [171,201] – 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 persuasive games can be tailored for a particular gamer type by using the results of the model and affinity mapping exercise; personalizing design for a specific gamer type is achieved by following Table 4.5, which presents a guideline for choosing appropriate strategies for each gamer type, and Table 4.8, which maps the strategies to game mechanics. The first example with the MMORPG shows how persuasive games could be tailored for a particular game genre, by using the results alongside the established links between the kinds of games enjoyed by each gamer type [171,201]. There are many ways in which persuasive games for health could be tailored based on the results from this study, either by using the strategies or the corresponding game mechanics, as given in Table 4.8. I have included three examples here to demonstrate the relationship between the findings and corresponding game mechanics.

Table 4.8: 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 & 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 behaviour
	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 behaviour, 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
	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 behaviour and outcome
	Epic meaning	Having something great as background story to give meaning to in-game actions. The story could link behavioural outcomes to player`s actions.
	Behaviour momentum	Players keep going because they feel what they are doing is valuable. Projecting behaviour outcome over a longer period will increase value and reinforce behaviour
	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 information 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 & 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 the desired behaviour is shown (but not rewarding either)
	Repeat simple action	Players enjoy repeating simple in-game actions

4.6.3 Summary: Recommended Design Steps

I have demonstrated the need to make specific considerations when designing persuasive games to motivate health behaviour. Specifically, I have revealed the need to tailor strategies to individual gamer types. I 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 [39] 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 4.6.

Step3: 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 appropriate 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 4.8. 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.

4.7 Limitations

There are limitations of applying the results of the model to game design mechanics. First, although I adapted the list of game design mechanics from Chapter 3, the list is by no means exhaustive or definitive. Second, I 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, I apply the results of the models at the level of a population (gamer type). As with all population-based personalization, the results will apply to the majority of the population; however, there may be outliers who do not respond in the predicted manner. Fourth, I make the findings actionable by providing examples of how the model results can be incorporated into persuasive game design. This process is not prescriptive of good game design – although the results can provide an advantage in choosing the best persuasive strategy to apply in a persuasive game, applying the findings may not ensure that a game is engaging or fun to play. Fifth, the study reports the perceived persuasiveness of various strategies, however, the actual persuasiveness of the strategies may differ when implemented in a specific game. Therefore, research presented later in this dissertation focused 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 later in this dissertation to validate the results of this study. Finally, this 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 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[136], it is possible that, just like other subjective measures, player typology may have low test-retest reliability.

This work has benefited from the large-scale study of persuasiveness of the strategies with respect to eating behaviour, and I can claim applicability in other health behaviour domains (due to the high level nature of the storyboard depicting the strategies). However, the model results should be applied with caution to other health behaviour 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 behaviour 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 the study) might moderate the impact of the strategies studied in this work.

4.8 Summary

Recent years have witnessed an increasing number of games designed for the purpose of changing human behaviour or attitude using various Persuasive Technology 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. This work is the first study to provide practical ways of applying and tailoring strategies in persuasive game design using the players' personalities, as described by gamer types. I conducted a cross validation of perceived persuasiveness of various strategies, and developed models showing the receptivity of gamer types to various strategies. The models revealed some differences in receptivity to various strategies between the seven gamer types, and I discussed these differences from the perspective of health behaviour, gamers' personalities, and persuasive game design. Through this study, I exposed the limitations of the current approaches to persuasive game design, and presented design opportunities for both a model-driven one-size-fits-all and a personalized approach to persuasive game design that is grounded in data. The 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. I highlighted the strategies that could influence the majority of players positively – best general strategies – and the ineffective strategies that incentivize few players. I 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, I suggest a mapping of strategies to common game design mechanics to bridge the gap between PT designers and game designers.

This work is the first study 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 behaviour change. I 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. My 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 behaviour change.

4.9 Contributions of the Work Presented in this Chapter

The four main contributions are as follows: First, I conducted a cross validation of the persuasiveness of ten commonly employed persuasive strategies and developed models showing the receptiveness of the seven gamer types to the PT strategies. Second, I 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: PT strategies, health behaviour, gamer types, and persuasive game design. Third, I highlighted the best overall strategies that were perceived as positive by most gamer types and the least efficacious strategies that were not perceived as persuasive by most gamer types. Fourth, I proposed model-driven design approaches for persuasive games for health that is based on developing persuasive profiles (comprising a list of suitable PT strategies) for each gamer type identified by BrainHex. Finally, to bridge the gap between PT designers and designers of games, I proposed a mapping of strategies to appropriate game design mechanics.

To the best of my knowledge, this is the first research to perform a large-scale validation of the persuasiveness of various strategies. I 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. The model-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 behaviour change.

In the next chapters, I apply the findings from this study to persuasive game design and evaluate whether a game design that is tailored to the individual gamer type following the model results and generated guidelines will be effective at motivating behaviour change than games designed using the design-by-intuition one-size-fits-all.

CHAPTER 5

MODEL-DRIVEN PERSUASIVE GAME DESIGN AND IMPLEMENTATION

In the previous chapter, I developed models for tailoring persuasive games to various gamer types. The main aim of this chapter is to describe the design and implementation of a model-driven persuasive game informed by design guidelines from the previous chapter. To achieve this objective, I developed a casual game similar to Space Invaders [47] – a popular fixed-shooter game – called *JunkFood ALIENS,* a game designed to promote healthy eating attitude and/or behaviour in young adults. I chose to clone the Space Invader game for two reasons. First, the game draws much of its appeal from demonstrating the classic struggle between good and evil using a clear symbolic language. Therefore, it is suitable for portraying the difference of the effects of healthy and unhealthy food and studying the impact of this portrayal on the player's attitude towards healthy eating. Second, a large-scale study would be necessary to effectively evaluate any model-driven persuasive game. As a result, I have a large-scale deployment of the model-driven persuasive game in an unconstrained environment. Space Invader's simple play style makes it appealing to a broader audience and is thereby suitable for conducting a large-scale study. I developed two versions of JunkFood ALIENS, one tailored to the Achiever gamer type and the other tailored to the Conqueror gamer type. Although the content, design, and implementation of the two versions of JunkFood ALIENS differ in the persuasive strategies employed, they both have identical game mechanics. Thus, the play experience of the game is the same – only the persuasive intervention changes. In this chapter, I present the design of JunkFood ALIENS, and present the two versions of the persuasive game intervention that were informed by the design guidelines for tailoring persuasive games to gamer types. This is followed by the discussion of the rationale underlying the game design process: the target gamer types and the persuasive strategies employed, the common features of both versions of the game, and present an overview of key game components and their underlying implications with respect to eating behaviour. I use screenshots from the final versions of the games when appropriate to illustrate some points.

5.1 Design Rationale

Considering the need to test the persuasive games in a large participant sample and diverse audience, my first design decision concerned the choice of platform for the game. The games need to be available to the largest possible audience and accessible across several platforms, including mobile phones and tablets. Consequently, I decided to develop a web-based game that could be accessible anywhere and that would not require users to install additional software other than the browser in order to access the games.

Following the decision to make a web-based game, the first option was to use Adobe Flash as a development platform. *Adobe's Flash* is a commonly used tool for developing highly interactive web-applications. However, it suffers from two main limitations. First applications developed using Adobe Flash require users to install a *Flash player* plug-in in their web-browser to be able to run the applications[47]. Second, currently, Adobe Flash does not fully support cross platform application, since it does not run on iOS (e.g., iPad)[47]. Therefore, a better choice was to use HTML5 – Hypertext Mark-up Language, JavaScript, and Cascading Style Sheets (CSS) as the development platform. HTML5 in the latest iteration of HTML addressing the needs and expectations of modern websites. Applications developed in HTML5 have some obvious advantages apart from requiring no additional installations, such as fast loading time, geo-location, local storage, and enhances audio and video capabilities, and device-independent – compatibility with a variety of devices including Smartphones, tablets, notebooks [47]. However, developing applications that would run on a variety of devices poses some challenges with scalability – ability to handle a variety of screen resolutions. HTML5 has an inbuilt Canvas element, which allows for easy rendering of 2D bitmap images, game graphics, and shapes using JavaScript. It is supported by most recent browsers [47,190]. As shown in Figure 5.1, the Canvas-based 2D graphics are easy to implement and could be widely accessible. However, canvas-based applications are resolution-dependent and therefore do not scale well to various screen sizes without additional programming. This is because the canvas element is based on bitmaps – .gif, .png, JPG formats which are the most popular form of computer graphics on the web [47]. Bitmap images suffer from image deterioration when the size of the image is increased. The Scalable Vector Graphics (SVG) present an effective way of implementing scalable 2D graphics for various device sizes [47,190]. SVG is an XML language for creating vector graphics developed and maintained by the World Wide Web Consortium (W3C) [190]. The HTML5 specifications provide for an ability to use SVG directly in HTML markup.

Figure 5.2 shows an SVG implementation of the Canvas graphics presented in Figure 5.1. SVG graphics and images automatically adjust to various screen sizes and application layouts without pixelating/degrading. **Error! Reference source not found.** demonstrates and compares the effect of resizing on bitmap and vector images.

Apart from producing graphics that do not pixelate, SVG has some other advantages over the Canvas-based bitmap graphics including the fact that one can write SVG directly into an HTML document without referencing to a file [47].

One constraint of using SVG is that although all modern browsers can open SVG files, currently, most of its features are not supported by all the browsers [47]. However, because games require high quality graphics which is one of the major strengths of SVG, I decided to use SVG in developing JunkFood ALIENS. As a result, the current implementation of JunkFood ALIEN is fully functional on Google Chrome only.

```
<!DOCTYPE html>
<html>
<body>

<canvas id="myCanvas" width="500" height="400" style="border:1px solid #c3c3c3;">
</canvas>

<script>

var c = document.getElementById("myCanvas");
var ctx = c.getContext("2d");
ctx.fillStyle="#FF0000";
ctx.fillRect (10, 10, 105, 100);
ctx.fillStyle="#084B8A";
ctx.fillRect (40, 40, 105, 100);
ctx.fillStyle="#FF0000";
ctx.fillRect (80, 80, 105, 100);

</script>

</body>
</html>
```

Figure 5.1: Canvas-based 2D Graphics Implementation and Sample Graphics

```
<!DOCTYPE html>
<html>
<body>

<svg width="640" height="480" xmlns="http://www.w3.org/2000/svg">
<g>
 <title>SVG Demo</title>
 <rect id="svg_1" height="122" width="122" y="155" x="146" stroke-width="5" fill="#FF0000"/>
 <rect id="svg_2" height="122" width="122" y="209" x="191" stroke-width="5" fill="#084b8a"/>
 <rect id="svg_2" height="122" width="122" y="266" x="241" stroke-width="5" fill="#FF0000"/>
 </g>
</svg>

</body>

</html>
```

Figure 5.2: SVG Graphics Implementation and Sample Graphics

5.2 JunkFood ALIENS Game Description

In this subsection, I present a detailed description of JunkFood ALIENS including the game features and user interactions. I conclude the subsection with a deconstruction of JunkFood ALIENS components.

JunkFood ALIENS is a game with play style similar to Space Invaders. It is a web-based game that runs and scales well in any internet-enabled device. Figures 5.3, 5.4, and 5.5 show screenshots of JunkFood ALIENS running on Tablets, Mobiles, and PC. Players interact with the game using either the mouse or the keyboard or by tapping the screen with the finger for those using touch screen devices

Figure 5.3: JunkFood ALIENS running on iOS (left) and Android Tablet (right)

Figure 5.4: The UI of JunkFood ALIENS rendered on mobile phones, iOS (left) and Android (right)

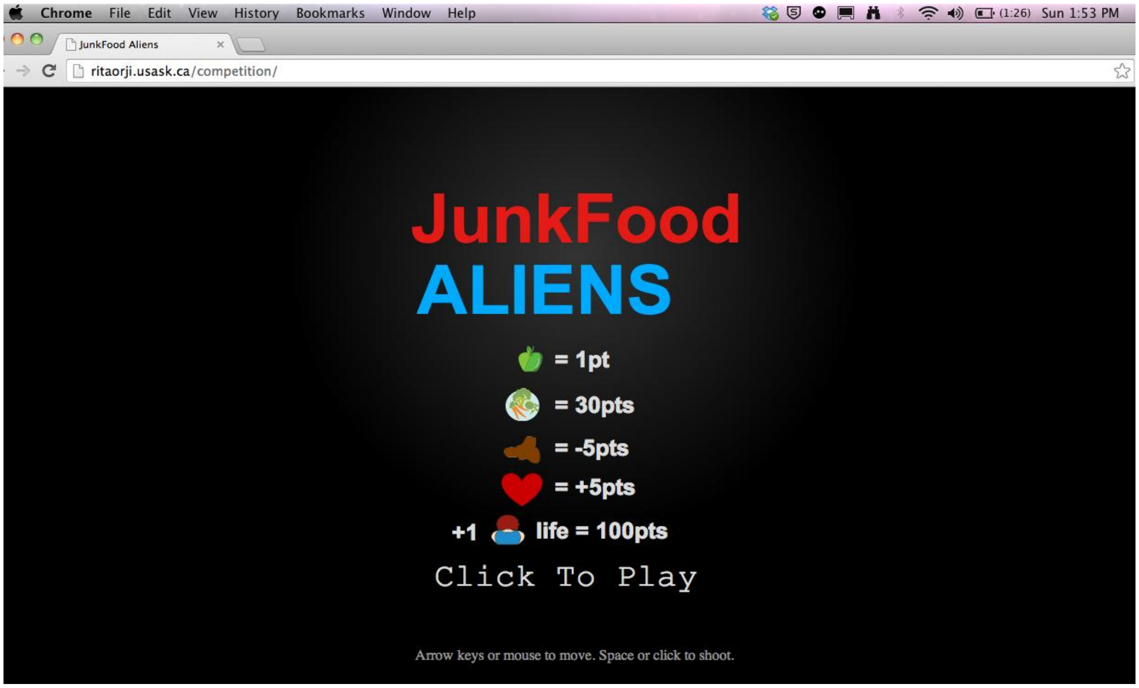


Figure 5.5: The UI of JunkFood ALIENS Running on the computer

5.2.1 JunkFood ALIENS Game Play

JunkFood ALIENS was designed to portray the conflicting impact of healthy and unhealthy eating and the struggle that individuals go through in their daily lives in order to choose between healthy and unhealthy food. Healthy foods were represented with fruits and vegetables while unhealthy foods were represented using foods that are colloquially referred to as "junk" foods (e.g. cupcakes, donuts, pizza, ice-cream, etc.). The players assume the role of a healthy eating hero on a mission to search for fruits and vegetables and to save the earth from invasion by junk food. Specifically, the player's task is to consume as many healthy foods as possible by shooting them using the player's avatar. However, for the players to survive and for them to successfully gain access to the healthy foods, they may need to eliminate unhealthy foods that are continuously shooting at them, blocking them from getting access to the healthy food, and trying to invade the earth as fast as possible. I chose this approach to demonstrate that healthy eating is not always easy in real life, however, it is beneficial. Individuals often encounter difficulties and barriers when trying to make healthy eating choices in real life. Previous research suggests that one way to overcome the barriers and difficulties associated with healthy eating is not to pretend that healthy eating is easy but to place the barriers side by side with the potential benefit of healthy eating. Individuals are likely to make a healthy eating choice if benefits outweigh barriers [143,144,158].

Specifically, JunkFood ALIENS begins by providing a general description of the game and instructions on how to play it on the welcome page. After players have read the instructions, they are prompted to enter their names and click the "Ok" button to navigate to the game page or the "Cancel" button to remain on the welcome page. Players must enter their usernames that are used in referencing them in the game before they are allowed access to the game page. The welcome page also contains a summary of the game rules as shown in Figure 5.5.

A typical game play consists of a player piloting a shooting avatar to battle a never-ending arrays (5 rows and 11 columns) of descending food aliens – a combination of healthy and unhealthy foods – that are randomly displayed as shown in **Error! Reference source not found.**. As a design alternative, I thought of using a sequential algorithm for displaying the food aliens or fixed positioning them, however, after brainstorming and consultations, I concluded that a random display is better as it eliminates the problem of mastering the game display pattern or the different combination of the food aliens.

The healthy food releases ***nutrients, vitamins*** and ***minerals*** (represented as drops of heart-shaped goodies) while the unhealthy food releases *cholesterol* and *transfats* (represented as drops of brown poisonous bullets). Also, after every thirty seconds (30 seconds) interval, the game releases a *Superfood* space ship – represented as a salad tray with a collection of fruits and vegetables high in nutrients. The game also provides players with four *protective shields* to hide from the poisonous bullets that are being fired by the unhealthy foods. At the beginning of the game each player has 6 lives and a life is lost each time a player is hit by the brown poisonous bullet. The game restarts if the player has no lives remaining or if the food aliens get to the ground before the player is able to kill all of them. The game is comprised of several levels and players' movement from a lower level to a higher level is determined by their ability to defeat the food aliens in the lower level. The speed at which the food aliens approach the ground increases as the game progresses and as players move from lower level to a higher level, increasing the challenge. **Error! Reference source not found.** presents a screenshot of the game panel. The game panel also displays the summary of the game rule shown in Figure 5.5.

The game was designed using the tutorial provided by Crowther et al. [47] as a template. I retained the basic game elements from the tutorial but changes were made to lots of the mechanics to suit the purposes of the MPG. Specifically, I added the intervention pages – the competition (global leaderboard) and reward (badges). I also changed the graphics, the speed of the food aliens, the number of lives, the game logic, added the levels, the gaining and losing of points, the random generation of food arrays, the separation of arrays into healthy and unhealthy food, the poisonous bullet, the heart-shaped goodies from the healthy food and their effect on the shields, the sound effects associated with various game-play actions, the game rule and its display in the game panel, username tracking, and made the game to play continuously – user-controlled ending time.

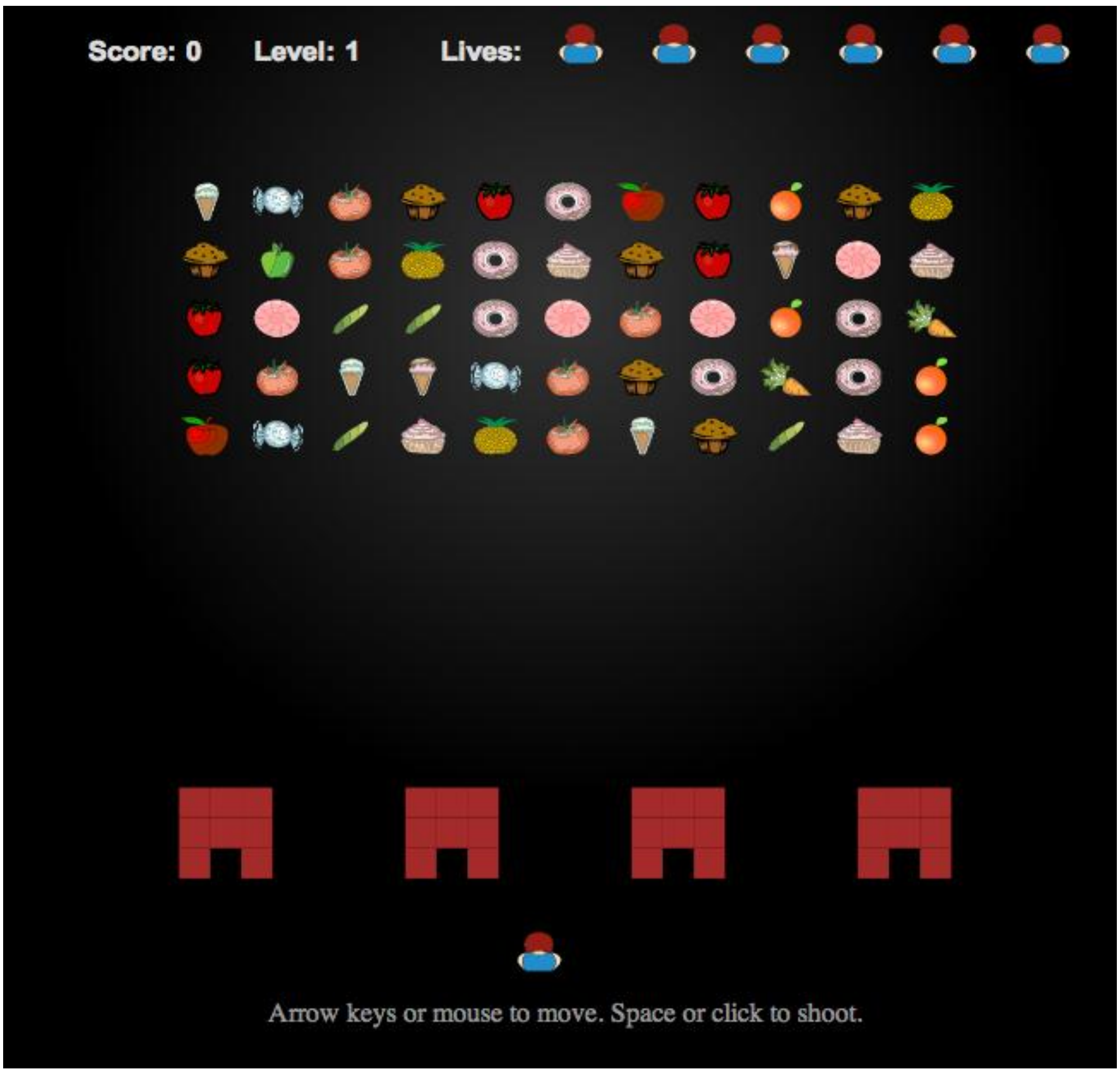


Figure 5.6: A Screenshot of the JunkFood ALIENS game panel. Food images drawn by a graphic designer.

5.2.2 Deconstructing the Underlying Features of JunkFood ALIENS

In this subsection, I describe the underlying stories behind the features – game components – of JunkFood ALIENS – mixture of healthy food and unhealthy food, unhealthy cholesterol and transfat, vitamins and minerals, the SuperFood, the protective shields, and losing and gaining lives as shown in Figure 5.7.

The Mixture of Randomly Displayed Junk foods and Fruits and Vegetable: Randomly displaying a mixture of healthy and unhealthy foods in the game is meant to depict the co-existence of healthy and unhealthy food in the real world. In our daily lives, we often need to choose between unhealthy and healthy food and most times, eating healthy meals entails eliminating or bypassing readily available unhealthy options. To represent this in the game, both healthy foods and unhealthy foods are randomly displayed. Shooting a healthy food attracts a point (+1) and shooting an unhealthy food attracts no point (+0). However, players need to eliminate the unhealthy foods because they shoot cholesterol and transfat at them, and block their access to the healthy foods.

The Poisonous Bullets and Vitamins&Minerals: The unhealthy foods release cholesterol and transfat (poisonous bullets) while the healthy foods release vitamins and minerals (heart). If the heart falls on the player, the player earns 5 points (+ 5) and if a poisonous bullet falls on the player, they lose 5 points (-5) and a life. The nutrients strengthen the player's avatar and the protective shields when it falls on them while the poisonous bullets destroy the protective shields and the player's lives. These features were added to demonstrate the positive and the negative effects of eating healthy and unhealthy foods respectively.

The Superfood: After every 30 second intervals, the game releases superfood – a collection of fruits and vegetables that are assumed to be equivalent to daily recommended serving of fruits and vegetable for adults [75]. The superfood is worth 30 points (+30) when consumed (by shooting it). The superfood, apart from portraying the positive effect of eating healthy food, highlights the subtle difference between consuming either a piece of fruit or vegetable and consuming a healthy amount of each as recommended by food and nutritionists [75].

The Protective Shields: At the beginning of the game, players are provided with four protective shields to protect against destruction by the poisonous bullets that are being fired by the unhealthy foods. The shields represent the human immune system which protects us against diseases attack. The poisonous bullets gradually destroy the shields as they fall on them while the nutrients strengthen the shields. This depicts the influence of healthy and unhealthy eating on the individual's immune system. The gradual destruction of the shields shows how our immune system is degenerated/weakened by unhealthy eating while the strengthening by the nutrients shows how healthy eating can help us build and maintain a good immune system.

The Losing and Gaining of Lives: A player is assigned a total of six lives at the beginning of the game. A life is lost each time a player's avatar is hit by the poisonous bullet and the game restarts if the player has no life remaining. Players also gain a life each time they accumulate up to a hundred points (+100). Similar to the protective shield, the losing and gaining of lives is meant to show how unhealthy eating can gradually destroy an individual's life and how healthy eating could lead to longer life in good health [204].

Finally, JunkFood ALIENS made effective use of sounds to make the game fun and to further differentiate players' in-game actions. Releasing of bullets by the player is associated with shooting sound; hitting a healthy food and the superfood is associated with cheerful eating sound; and hitting an unhealthy food produces a bomb sound. Similarly, if a poisonous bullet falls on the player's avatar, it produces a prolonged destructive bomb sound – different from the sound of shooting the unhealthy food – and the nutrients falling on the player's avatar produces a cooling water sound.

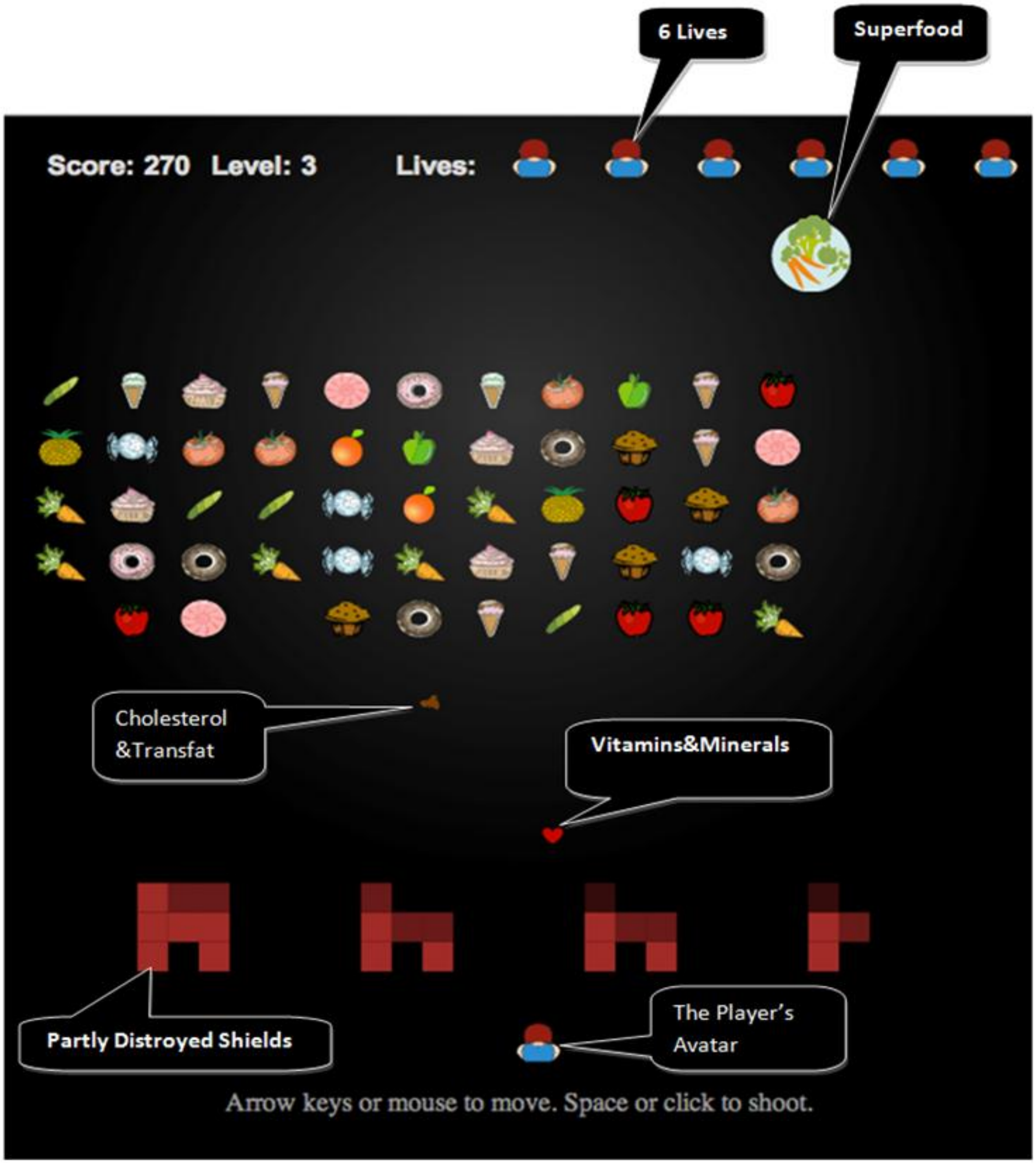


Figure 5.7: A Screenshot of the JunkFood ALIENS showing the game components.

5.3 Tailoring JunkFood ALIENS to Gamer Types

Tailored persuasive games is a term used to describe persuasive games that are tailored to individual gamer types using their best strategies while contra-tailored persuasive games is used to describe persuasive games that are developed using strategies that have no significant effect on the player or strategies that are perceived as negative by the gamer type. To enable studying the influence of tailored persuasive games on players attitude, I designed two model-driven persuasive game adaptations of JunkFood ALIENS: The competition&comparison-based JunkFood ALIENS (JunkFood ALIENS-C) and reward-based JunkFood ALIENS (JunkFood ALIENS-R) tailored to achievers and conquerors respectively (See Chapter 4). In this subsection, I briefly describe the rationale for choosing these gamer types and the strategies employed in the persuasive game design. This is followed by detailed descriptions of the two versions of JunkFood ALIENS.

5.3.1 Rationale for Choosing Gamer Types and Persuasive Strategies for Tailoring

Considering that it is not feasible to design tailored persuasive games for all the seven gamer types using all the strategies highlighted by the model, I decided to design for two out of the seven gamer types – achievers and conquerors – using two distinct strategies. I chose to design for achievers and conquerors for two main reasons. First, these two are among the most common gamer types. They are identified in both of the main existing player typologies – Bartle's and BrainHex (BrainHex`s conqueror type corresponds to the Bartle`s killer type [201]). Second, achievers and conquerors show distinct perceptions of most of the strategies in the model; they perceive 5 out of the 8 strategies differently (as shown in Table 5.1)– thereby making it interesting to study and compare the influence of both tailored and contra-tailored persuasive games on their attitudes.

Table 5.1: Standardized path coefficients (β) for achievers and conquerors. Distinct coefficients are highlighted with red oval shapes. All displayed coefficients are significant at p<.05, whereas '-' represents non-significant coefficients – Taken from the model displayed in Chapter 4.

Strategies	CMPT/ CMPR	COOP	CUST	PERS	PRAS	SEMT/ SUGG	SIML	REWD
Achiever	-	.15	-	-	-	.10	-	.10
Conqueror	.25	-	-	.12	-	.12	.14	-
CMPT/CMPR = competition and comparison, COOP = cooperation, CUST = customization, PERS = personalization, PRAS = praise, SEMT/SUGG = self-monitoring and suggestion, SIML = simulation, REWD = reward.								

The choice of persuasive strategies was guided by the following considerations. First, the chosen strategies should have opposite effects on the two gamer types – achievers and conquerors – with respect to their perceived persuasiveness. This enables a comparison between the influence of persuasive games designed using the best strategy (tailored) versus the worst strategies or the strategies that have no significant influence on the gamer types (contra-tailored). Second, one of the strategies should be among the strategies classified as the '*best general strategy*' from the model, while the other should belong to the group classified as '*least efficacious strategies*'. This allows to examine and compare the overall performance of the persuasive games designed using both a best general strategy and a least efficacious strategy for the general gamer group. As a result, I decided to tailor the persuasive game using the competition&comparison and the reward strategies. From the model, competition&comparson emerged as the best strategy for conquerors and it is also one of the best general strategies that influences most of the gamer types positively. On the other hand, reward is the second best strategy (after cooperation) for achievers but it is among the least efficacious strategies that may not have significant influence on most other gamer types. I chose reward instead of cooperation because although cooperation is the best strategy for achievers, it is neither among the best general strategies nor the least efficacious strategies. In addition, it is not easy to demonstrate cooperation in the prototype implementation of the JunkFood ALIENS. Finally, the reward strategy is an interesting choice as it has been commonly applied in persuasive games and gamification systems without broad consideration of its efficacy. Consequently, for the model-driven persuasive games, I designed competition&comparison-based JunkFood ALIENS (JunkFood ALIENS-C) – tailored for conquerors – and reward-based JunkFood ALIENS (JunkFood ALIENS-R) – tailored for achievers.

5.3.2 Reward-based version of JunkFood ALIENS

To incorporate reward into the JunkFood ALIENS, the game awarded players badges in recognition of their in-game achievements. There are a total of five badges that could be earned in the game – Fruit&Vegetable FAN, Fruit&Vegetable CAPTAIN, Fruit&Vegetable LEGEND, Fruit&Vegetable KING, and Fruit&Vegetable HERO. The badges are tied to both the player's game score and the game levels. Similar to most games, I used a logarithmic reward structure in setting up requirements for earning the badges. This means that initially, the badges were easy to earn but required more work as players advance in the game as shown in Figure 5.8. To give players a sense of direction, enable them to set goals, and also stay motivated, players were made aware of achievable badges in the game and the requirements to earn each of them. Specifically, at the beginning of the game the badges were locked, however, the names of the badges, the total score (points) and level required to unlock each badge, the total number of badges earnable, and the highest badge that could be achieved in the game were made visible to the player in the intervention page as shown in Figure 5.8. They were able to visualize and aim at getting any of the badges. Again, before a player achieves the points and the level required to earn a badge, the game displays the phrase "No badge has been earned" both in the game panel and in the intervention page.

Once the player earn a badge, the badge appear in the left hand side of the game panel. The badges accumulated by the player during the game, the badges yet to be unlocked, and the player's total gamer score are also displayed in the intervention page (as shown in Figure 5.9) which automatically appears after every minute. Figure 5.10 shows a successful game play scenario where all the badges were unlocked.

Again, although the game restarts every time a player loses, players do not lose already earned badge(s) but must restart from level 1 to attain the desired level and scores to unlock new badges.

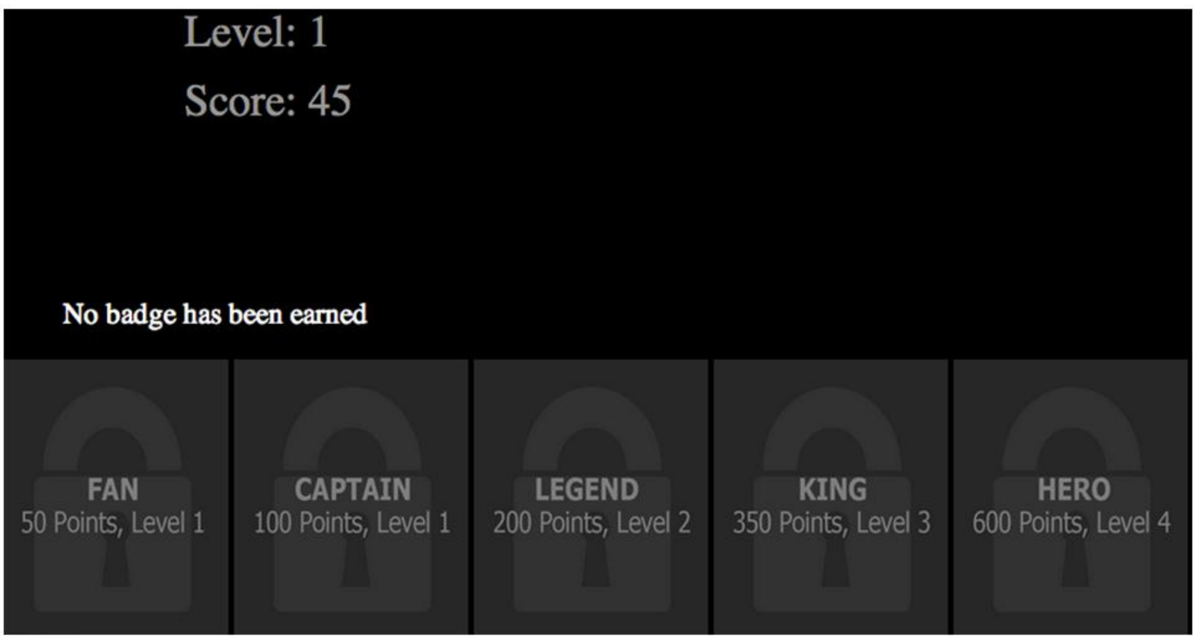


Figure 5.8: Screenshot of the intervention page showing the locked badges, the points, and levels required to unlock the badges.

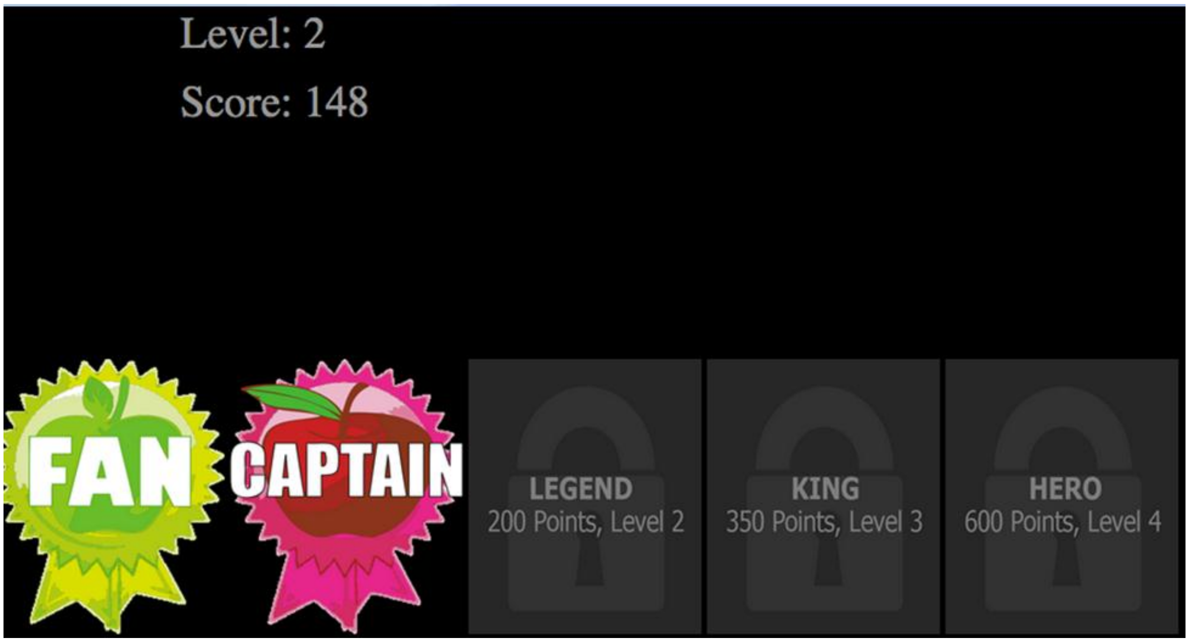


Figure 5.9: Screenshot of the intervention page showing the Badges earned and the badges yet to be unlocked

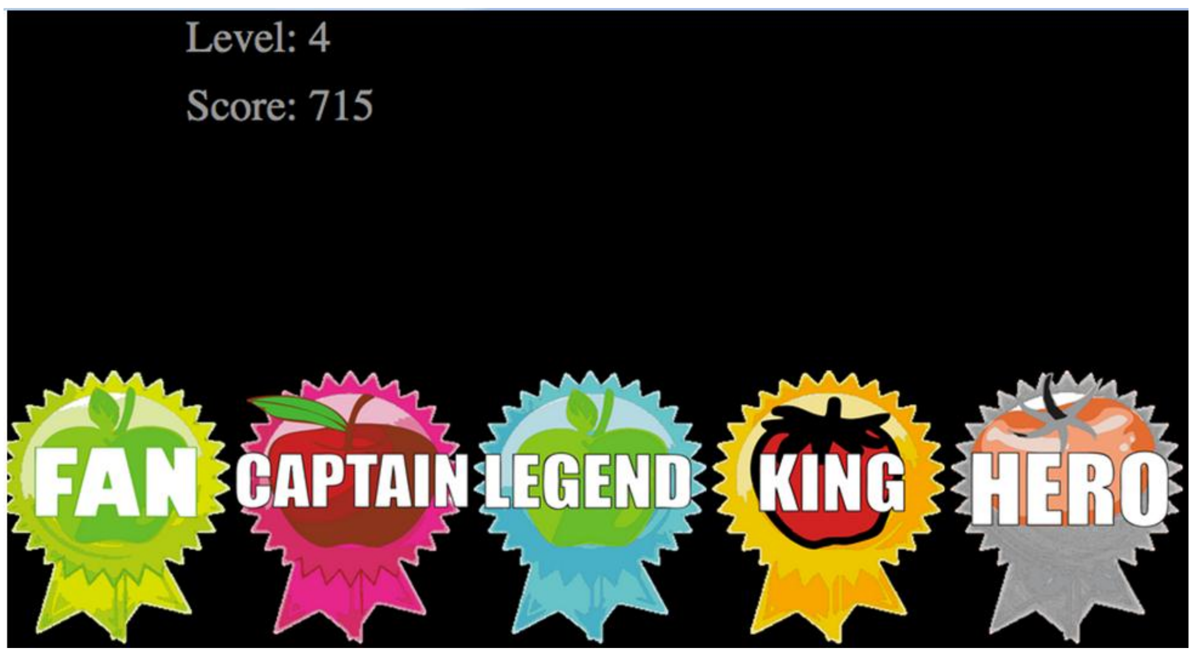


Figure 5.10: Screenshot of a successful game play scenario showing all badges unlocked

5.3.3 Competition&Cooperation-based Version of JunkFood ALIENS

To incorporate competition&comparison into JunkFood ALIENS, I added a leaderboard that displays and compares players' performance – their names, scores, and rank as shown in Figure 5.11. Specifically, as in multiplayer games, the leaderboard simulates competition&comparsion between five players. The decision to limit the number of players in the competition to five was to keep the players motivated by making it easy for them to visualize and compare themselves with other players.

The competition&comparison strategy requires a multiplayer game, however, JunkFood ALIENS by its design is not a multiplayer game. Therefore, to create the feel of competition&comparison, I added a global leaderboard that tracks and displays global high scores list of players to encourage competition. To achieve this, I hard coded some selection of names (a total of fifty unique names) representing registered and active players in the game. After players have successfully entered a username and before they start playing the game, they are automatically assigned to compete with four other randomly generated players from the list of the players in the database as their opponents in the JunkFood ALIENS-C. Because the competition&comparison is simulated, the leaderboard appears after the player has played the game for one minute displaying the five players' names, their scores, and ranks relative to each other. As shown in Figure 5.11, the real player's position is highlighted in the leaderboard for easy visibility and also to mitigate any confusion that may result from having identical names in the leaderboard. The leaderboard also displays the player's current game level.

To determine the scores and ranks of the players in the leaderboard, I used a rank generation and score calculation algorithm. Specifically, the game randomly generates and assign players to ranks ranging from 1 to 5. Using the individual player's ranks and the real player's score, the scores for the hypothetical players are calculated. The details of the algorithm used in determining the players' ranks and scores is given in Figure 5.12.

Level: 2

Game Performance Leaderboard

Rank	Player Name	Score
1st	Stephen	507
2nd	Rita	471
3rd	Andrea	467
4th	Donna	401
5th	Jose	367

(a)

Level: 3

Game Performance Leaderboard

Rank	Player Name	Score
1st	Rita	599
2nd	Stephen	460
3rd	Donna	240
4th	Jose	166
5th	Andrea	136

(b)

Game Performance Leaderboard

Rank	Player Name	Score
1st	Rita	372
2nd	Heather	348
3rd	Charles	332
4th	Jean	331
5th	Jane	312

(c)

Game Performance Leaderboard

Rank	Player Name	Score
1st	Jean	950
2nd	Charles	886
3rd	Jane	785
4th	Rita	557
5th	Heather	531

(d)

Figure 5.11: Leaderboards showing a player's position at level 2 (a) and level 3 (b) and another player's position at level 1 (c) and level 4 (d).

```
1.   At the beginning of the game, randomly retrieve 4 names from the array
     containing fifty names and position them in the leaderboard according to
     the order generated. The real player occupies the fifth position.

     /* This initial ranking is not visible to the player because the
     leaderboard does not appear until after the player has played the game for
     a minute.*/
     /*The next steps show how the scores and ranks of players are generated */


2.   Randomly generate a rank for the real player from number 1 to 5.
3.   Swap the real player's current place with any player occupying the
     position corresponding to the rank generated in 2.
4.   Get the real player's score.
5.   Calculate a unit/ratio of score differences for the players as an absolute
     value of the real player's score divided by the rank. Unit Score =
     |score/rank|.
6.   For players at higher ranks relative to the real players:
     Calculate their scores as ➔ real player's score + unit score - (a random
     number ≤ unit score) + offset. /*Offset represents the position of the
     particular player relative to the real player. For example, the player
     immediately at the next higher rank before the real player's position is
     at offset 1. */
7.   For players at lower ranks relative to the real players:

     Calculate their scores as ➔ real player's score - unit score + (a random
     number ≤ unit score)- offset. /*Offset represent the position of the
     particular player relative to the real player. For example, the player
     immediately at the next lower rank  (after the real player) is at offset
     1. */

8.   Finally, sort the leaderboard in descending order of players' score.
```

Figure 5.12: Algorithm for determining players' ranks and scores

This algorithm used the real players score and rank to determine the hypothetical players score thereby ensuring that the hypothetical players' scores do not appear obviously unreal. As a design alternative, I tried using an ordinary random number generation algorithm to assign scores to the hypothetical players – without taking into consideration the real player's score. However, it generated scores that looked quite different from each other and unreal. I also considered assigning ranks to the real players based on their game performance in each minute, however, this appeared rather problematic because individual players have different gaming capability. Using this approach keeps less efficient/experienced gamers almost always at the lower ranks in the leaderboard. As a result I used the algorithm given above which closely simulates a real leaderboard and ensures that all players of JunkFood ALIENS-C get the same feel of where they are in the leaderboard, regardless of their score.

5.4 Integrating the Interventions into the Game

Note in this section how the intervention page – depicting the appropriate persuasive strategies (competition or reward) – popped up each minute displaying the appropriate persuasive strategies to the users. It is also important to reiterate that the two versions of JunkFood ALIENS are identical without the intervention pages. They involve identical game play and are identical from the perspective of a rhetoric-based intervention. The only difference between the two versions of JunkFood ALIENS is the persuasive strategies employed – whereas the JunkFood ALIENS-C employed competition, the JunkFood ALIENS-R employed the reward. As a result, it is expected that users will have the same experience playing the two versions of JunkFood ALIENS if we remove the intervention.

CHAPTER 6

MODEL-DRIVEN PERSUASIVE GAME EVALUATION RESULTS

The previous chapter describes the design and implementation of the two versions of a model-driven persuasive game: Competition&Comparison-based JunkFood ALIENS (JunkFood ALIENS-C for brevity) and Reward-based JunkFood ALIENS (JunkFood ALIENS-R for brevity), which were informed by the model described in Chapter 4. This chapter describes the evaluation and results from the two versions of JunkFood ALIENS. The evaluation is aimed at investigating whether the persuasive games will promote a positive healthy eating attitude, self-efficacy, and intention. In addition, it also investigates whether players who played the tailored persuasive game will show more positive changes in attitude, self-efficacy, and intention than those who played either the contra-tailored or randomly assigned persuasive game. More specifically, I am interested in examining whether achievers would find the JunkFood ALIENS-R more persuasive than the JunkFood ALIENS-C and whether conquerors would find JunkFood ALIENS-C more persuasive than JunkFood ALIEN-R. In this chapter, I present my final research contribution: an evaluation of model-driven persuasive games. I present the findings from a large-scale quantitative evaluation involving 802 gamers and a small scale follow-up evaluation performed with 6 participants – 3 achievers and 3 conquerors. The chapter begins with the description of the quantitative study design method, measurement instruments, data collection and filtering process. This is followed by a description of the study participants, the data analysis process, and results. The chapter concludes with a presentation of the follow-up study and an in-depth discussion of specific insights from the studies.

6.1 The Quantitative Study

It is desirable to measure the effectiveness of JunkFood ALIENS with respect to its ability to promote actual healthy eating behaviour; however, this is not feasible within the scope of this research for two major reasons: First, it is difficult to measure eating behaviour "in the wild". The most common method of measuring eating behaviour is self-monitoring, which is still a subjective measure and labour intensive. More importantly, there are a number of external and environmental factors beyond the control of an individual (e.g., lack of access to full-service grocery stores, high costs of healthy foods) that can affect an individual's eating behaviour. Therefore, to successfully measure the effectiveness of any healthy eating intervention with respect to behavioural change, these factors ought to be controlled. Second, the cost of conducting a controlled or semi-controlled large-scale study, is very high. As a result, it is a common practice for healthy eating intervention designers to evaluate the effectiveness of their intervention by measuring its effect on individual's attitude towards healthy eating as opposed to their influence on overt behaviour [77,145,148,149,188].

Therefore, I evaluate the efficacy of JunkFood ALIENS with respect to its ability to influence a positive change in healthy eating attitude, self-efficacy, and intention.

6.1.1 Method

This section presents the detail of the quantitative study method, data analysis, and the results.

6.1.1.1 Measuring Change

The first step in any behaviour change is to address the factors (determinants) that mediate behaviour change. According to several behavioural studies and theories, attitude, self-efficacy, and intention are the main predictors of behaviour [4,158]. For example, in a meta-analysis of 26,987 samples, Kim and Hunter [115] found a strong attitude-behaviour relationship with an overall average correlation of 0.79 and behavioural intention-behaviour correlation of 0.82. According to Ajzen & Fishbein [3], behavioural intentions when properly measured account for an appreciable proportion of variance in actual behaviour. This implies that one can predict specific behaviour from intention to engage in that particular behaviour with considerable accuracy.

Although a number of theories posit that behaviour intention (as opposed to attitude) is the closest antecedent of actual behaviour– for example, see the Theory of Planned Behaviour (TPB) [4]. Research has shown that a specific attitude towards a behaviour in question can predict specific behaviours quite well. For instance, a meta-analysis of 88 attitude-behaviour studies by Kraus [118] shows that attitude significantly predicts future behaviour. Similarly, Verplanken and Faes [188] found an equal and significant correlation of 0.29 between healthy eating attitude and healthy eating behaviour and the same correlation between healthy eating intention and healthy eating behaviour.

These results show that although the attitude-behaviour relationship has often been thought of as mediated by behavioural intention, attitude does in fact have a direct relationship with behaviour.

According to Ajzen, one of the problems with the past attitude-behaviour research is that the researchers measured a general attitude and then concluded that attitude is a poor predictor of specific behaviour Ajzen and Fishbein [3]. To predict specific behaviour, a specific attitude about the behaviour should be measured. For example, if one is interested in predicting healthy eating behaviour in the next two weeks, he/she should also measure attitude towards healthy eating at the same time and place (if applicable – if he/she is interested in predicting healthy eating behaviour at a particular location e.g., restaurant or grocery store).

Similarly, self-efficacy, which describes an individual's belief about his/her ability to perform the behaviour in question [13], has repeatedly been found to be a good predictor of actual behaviour in a range of healthy behaviour domains, explaining more than 50% of variability in behaviour in some cases [1]. As a result, self-efficacy belief is at the center of most models of health behaviour that have found it to be a consistent predictor of behaviour (for example see [4,13,158]). In the area of smoking cessation, Kok et al. (1992) found that self-efficacy could cross-sectionally explain 64% of the variance of intention as well as behaviour. Specifically, in the area of healthy eating, Schwarzer and Fuchs [162] found that self-efficacy is the best predictor of healthy eating behaviour for females. Similarly, Orji et al. [144] also found self-efficacy as the best predictor of healthy eating. For a detailed review of self-efficacy and healthy behaviour, see [1,162].

It may appear that explaining 60%, 50%, or less of unaccounted for variance in health behaviour is not good enough. However, as Hunter and Schmidt [93] pointed out:

"*The "percent variance accounted for" is statistically correct but substantively erroneous. It leads to severe underestimates of the practical and theoretical significance of relationships between variables. This is because R^2 (and all other indexes of percentage of variance accounted for) are related only in a very nonlinear way to the magnitudes of effect sizes that determine their impact in the real world. (p, 190).*"

Similarly, Sutton [176] pointed out that the explained percentage of variance is a pessimistic measure of effect size. To illustrate this, they used a smoking cessation intervention with 100 participants for both intervention and control group. The success rate of giving up smoking was 70% and 30% for intervention and control group respectively. The difference in success rate for the two groups was 40%, The relative success rate shows that the intervention more than doubled the participants' chances of quitting. All these measures suggest that the intervention was very successful at helping people quit smoking. However, when these findings are expressed in terms of percentage variance accounted for, the result is only $R^2 = 0.16$ (16%), which appears much less impressive [176].

Following from this, attitude, self-efficacy, and intention are good predictors of behaviour and could be used to evaluate the effectiveness of interventions aimed at promoting healthy attitudes and/or behaviour.

In persuasive and behaviour change literatures, pre and post-test measured following exposure to an intervention is the predominant method of assessing attitude, self-efficacy, and intention to change. I adopted this approach to evaluate the effectiveness of the JunkFood ALIENS. Participants were presented with pre-(baseline) and post-(exit) surveys before and after playing their randomly allocated version of JunkFood ALIEN once. Considering the research objective, the study used a 3 (achievers, conquerors, and general – all other gamer types apart from achievers and conquerors combined) by 2 (JunkFood ALIENS-C vs. JunkFood ALIEN-R) factorial design.

6.1.1.2 Study Design

The study was conducted online and it took an average of an hour for each participant to complete. To evaluate the effectiveness and impact of the two versions of JunkFood ALIENS, I hosted the games on a University of Saskatchewan server and recruited participants to play the game online. At the beginning of the study, participants completed a pre-survey containing questions for assessing (1) participants' demographics; (2) 28 BrainHex questions for classifying participants to gamer types [201]; (3) Seven questions for assessing baseline attitude towards healthy eating; (4) Seven questions for assessing healthy eating intention; and (5) Five questions for assessing self-efficacy towards healthy eating. Depending on the participants' gamer type – as obtained using the 28 BrainHex questions – participants were categorized into 3 major experimental groups: *Achievers, Conquerors,* and the *General* group. The Achiever group consisted of players whose BrainHex gamer type is Achiever; the Conqueror group consisted of players whose BrainHex gamer type is Conqueror; and the General group consisted of the remaining five gamer types: Daredevil, Mastermind, Seeker, Socializer, and Survivor.

To evaluate and compare the effectiveness of the tailored and contra-tailored persuasive game, and the persuasive game designed using a random strategy, I used a between subject study. In this regard, I developed three experimental conditions: *The Tailored Condition, Contra-Tailored Condition,* and *Random Assignment Condition*.

The Tailored Condition (TC): Participants in this experimental condition are either achievers or conquerors. Participants with these gamer types were randomly assigned to this condition and played a tailored version of the persuasive game, i.e. a game that was implemented using a strategy that the model suggested would be persuasive, depending on their gamer type as highlighted in Chapter 5. Specifically, these participants played either the JunkFood ALIENS-C (Competition) or JunkFood ALIENS-R (Reward) depending on whether they were a Conqueror or an Achiever, respectively.

Contra-Tailored Condition (CTC): Participants in this experimental condition are either achievers or conquerors. Participants with these gamer types were randomly assigned to this condition and played a contra-tailored version of the persuasive game depending on their gamer type, i.e. a game that was implemented using a strategy that the model suggested would *not* be persuasive. Specifically, these participants played either the JunkFood ALIENS-C or JunkFood ALIENS-R depending on whether they are achiever or conqueror respectively.

Random Assignment Condition (RAC): Participants in this experimental condition were all from the general group. Participants in this condition were randomly assigned to play either the JunkFood ALIENS-C or the JunkFood ALIENS-R without considering their gamer type or strategy preference, see Figure 6.1.

The participants were randomly assigned to one of the three experimental conditions depending on their gamer type. Half of all the participants belonging to the achiever type and the conqueror type were randomly assigned to play the tailored condition and the remaining half played the contra-tailored condition. To achieve this, each of the three gamer groups (achiever, conqueror, and general) was associated with two surveys: The first survey was linked to the JunkFood ALIENS-C and the second one was linked to the JunkFood ALIENS-R. Hence, in total, I created a total of six separate surveys – two for each gamer group. The six surveys contained the same set of questions, however, within the survey each participant was directed to play the appropriate game version as determined by their randomly assigned experimental condition.

To determine each participant's gamer type in order to assign them to the appropriate experimental condition, I automated the BrainHex questions for classifying players to various types [201] using a custom script written in the online survey software Survey Gizmo. Each participant began the survey with reading and consenting to the survey terms as written in the U of S consent form. This was followed by the BrainHex questions for classifying participants to various gamer types. After the participants successfully responded to the BrainHex questions, they were randomly assigned to one of the two surveys associated with their gamer type. The participants began the actual study by completing the baseline survey, after which they were directed to the game page where they played the appropriate game version. After they completed playing the game, they were directed back to the survey page to complete the exit survey. Figure 6.1 presents a diagrammatic summary of the evaluation steps.

On the game page, participants were provided with a detailed description of the game, the game rules, and instructions on how to play the game as described in Section 5.2. Participants were required to enter a username, after which they played the game for at least 20 minutes and recorded their game performance. Specifically, participants were required to record their scores, ranks, and game level or the score, level, and highest badge earned depending on whether the participant played the competition or the reward version respectively. Participants were instructed that to complete the game section, they had to record at least twenty (20) different scores, ranks, levels, and badges displayed on 20 different appearances of the intervention page which appeared every minute as described in Section 5.2. Participants were required to keep a record of their own game performance for two main reasons: First, it ensured that participants paid attention to the intervention page – which contained the PT strategies – and the information contained therein. Second, it helped ensure that participants actually completed the game. The diagrammatic summary of the participants' activities in the game page is presented in Figure 6.2.

Participants were required to submit their recorded performance indices back in the exit survey. To ensure that they keep accurate records of their performances, they were also instructed that for their response to be accepted, the submitted performance indices must correspond to their tracked record in our database. In addition, participants in the JunkFood ALIENS-R (reward) version were required to earn at least two badges before they were counted as having successfully completed this game. This meant that they had to continue playing the game (even after they have played the game for 20 minutes) until they have been able to earn at least two badges.

The game plays continuously – participants decide when to exit from the game – but restarts from level one each time a participant loses the game. This allowed participants to play the game as long as was required. After participants completed playing the game and recording the required performance indices, they were redirected back to the survey page where they completed the exit survey. The exit survey contained questions for assessing post-intervention attitude, self-efficacy, and healthy eating intention. It also contained the *Intrinsic Motivation Inventory (IMI*) [159] scale for assessing the players' experience from playing the game. I also included an open-ended question that allowed participants to provide additional qualitative comments about the games and the features they enjoyed. The questions used in assessing healthy eating attitude, self-efficacy, and intention were the same for both the baseline and exit survey.

After successful completion and submission of the survey, each participant was given a unique code to indicate that they successfully completed the study and to receive their compensation.

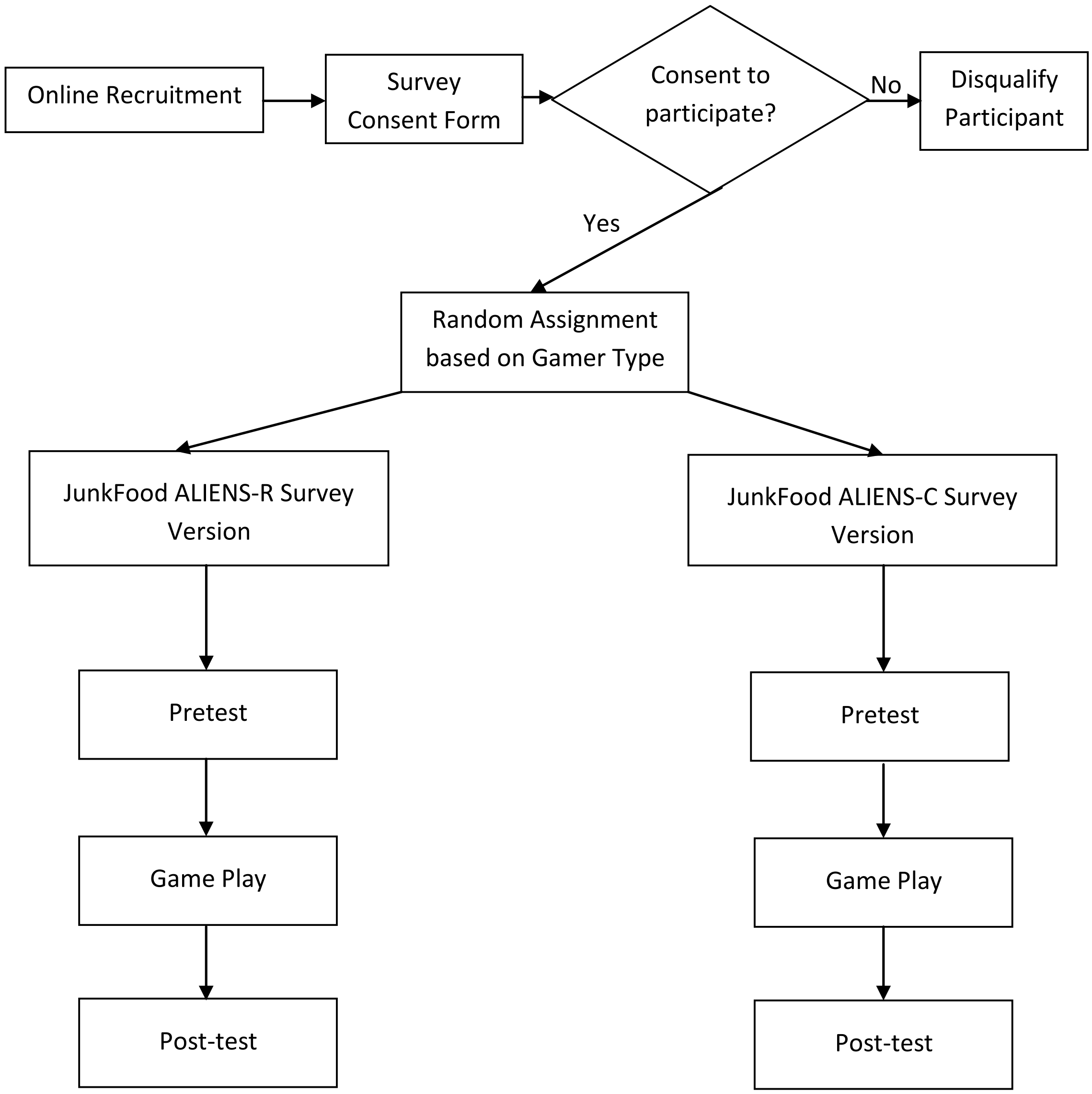


Figure 6.1: The Flow of the Evaluation Study Design

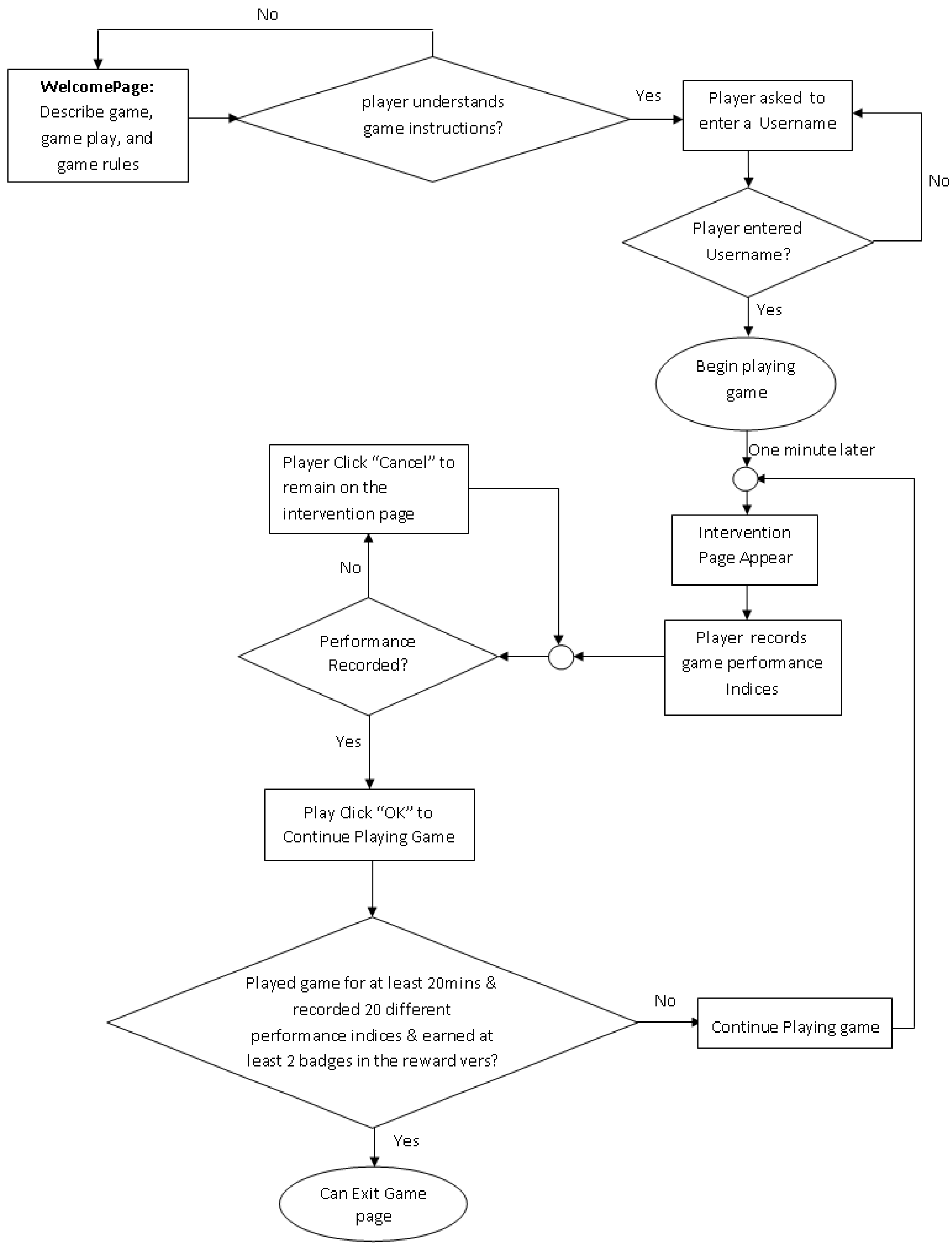


Figure 6.2: Detailed Flow Chart of the Game Play Evaluation Design

6.1.1.3 Measurement Instrument evaluation

Attitude Towards Healthy Eating: According to Ajzen, attitude towards a behaviour is defined as "*a person's overall evaluation of performing the behaviour in question."* [5]. This means a person's overall feeling, belief, or opinion of approval or disapproval towards performing the behaviour in question.The baseline and exit surveys measured attitude towards healthy eating using a semantic differential scale, which consisted of seven items. An example of a question in the attitude towards healthy eating scale is *"Eating healthy food in the next two weeks would be?'* All of the questions were measured using participants' rating of a 7-point Likert scale with anchoring adjectives as good – bad, pleasant – unpleasant, beneficial – harmful, enjoyable – unenjoyable, valuable – worthless, useful – useless, and important – unimportant. The questions used in assessing participants' attitudes towards healthy eating was adapted from [5] and has been validated on healthy eating by [129,145,188]. For each participant, I obtained two mean values related to their attitude towards healthy eating: one representing their *baseline attitude towards healthy eating* (obtained from the baseline survey), and the other from the exit survey representing their *post-intervention attitude towards healthy eating* (obtained from the post-test survey).

Healthy Eating Intention: The baseline and exit survey contained seven questions for assessing healthy eating intention adapted from [5,129]. All of the items were measured using participants' rating of a 7-point Likert scale ranging from "1 = Extremely Unlikely" to "7 = Extremely Likely". An example of a question in the healthy eating intention scale is "*I plan to eat healthily during the next two weeks*". From the surveys, for each participant, I obtained two mean values related to healthy eating intention: One representing their *baseline healthy eating intention* – obtained from the baseline survey – and the other from the exit survey represents their *post-intervention healthy eating intention.*

Self-efficacy Towards Healthy Eating: Self-efficacy is a term that is used to describe an individual's belief about his/her ability to perform the behaviour in question [13]. The baseline and exit surveys contained five questions for assessing self-efficacy towards healthy eating adapted from [51,129,149]. All the questions were measured using participant agreement with a 7-point Likert scale ranging from "1 = Strongly disagree" to "7 = Strongly agree". An example of a question in the self-efficacy towards healthy eating scale is "*I am confident that I could eat healthily within the* *next two weeks if I want*". For each participant, I obtained two mean values related to self-efficacy towards healthy eating: one representing their ***baseline self-efficacy towards healthy eating*** *(*obtained from the baseline survey), and the other from the post-test survey represents their *post-intervention self-efficacy towards healthy eating.*

Play Experience Measure: I collected player experience measures immediately following the game play using standardized scales commonly used for assessing player experience. Specifically, I used the *interest-enjoyment*, *perceived competence*, and *effort* subscales of the Intrinsic Motivation Inventory (IMI) [132,159], which was included in the exit survey. IMI is a multidimensional scale used in measuring participants' subjective experiences with performing a target task. The IMI subscales were assessed using 14 questions adapted from [132], which has been used in evaluating experience playing video games (e.g., [160]). Participants responded by showing their agreement to the questions in a 5-point Likert scale ranging from "1 = Strongly disagree" to "5 = Strongly agree". An example of a question in the IMI scale is "*I enjoyed the JunkFood Alien game very much"* and *"I think I am pretty good at playing JunkFood Alien game.*" Detailed questions used in measuring the various scales is included in the appendix.

6.1.1.4 Data Collection and Filtering

I recruited participants for this study using Amazon's Mechanical Turk (AMT). AMT was used for two main reasons – first, AMT has become an accepted method of gathering users' responses [32,81,85,88,125,131]; and second, I needed a large participant sample and diverse audience for the study. As stated in Chapter 4, AMT allows access to a global audience at a relatively low cost, and ensures efficient survey distribution, and high quality results [32,131]. I followed the recommendations for performing effective studies on AMT by Mason and Suri [131] to overcome potential problems associated with recruiting from AMT, such as the issue of mechanical bots completing a survey. Specifically, I used captcha and some open-ended questions that require some degree of intelligence and typing to ensure that only human participants are retained in the survey. I ensured that participants could respond to the study only once using a mechanism provided by AMT that allows for collection of responses from unique participants. I also examined the workers' identifications provided by the AMT, which further ensured that no duplicate responses were received. I included time stamps to ensure that participants did not complete the study without reading or understanding it. I tracked the total time taken by participants to complete the survey. The study took an average of 1 hour to complete. Furthermore, I employed attention questions to ensure that participants were actively considering their answers. Specifically, I 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 and understanding the questions. For example, having the question: "*Eating monster in two weeks time would be: Choose undesirable if you are reading this text*" in between the questions for measuring participants' attitudes towards healthy eating. Responses from participants who got the attention questions incorrect were discarded. I collected a total of 901 responses and retained a total of 802 valid responses, which were included in the analysis.

Before the main study, I conducted two pilot studies. The first pilot study was conducted on 40 participants (30 participants from AMT and 10 participants recruited from U of S) to test the validity of our study instruments. The preliminary evaluation showed similar reactions from the participants recruited from AMT and those from the university; however, it also revealed a need to restructure some of the study questions and design. I restructured as necessary and conducted a second pilot study on another 4 participants – the participants played the game and completed the survey using a think aloud approach [124]. The second pilot study shows that participants understood the study instruments, experimental set-up, and are therefore able to complete the study without guidance.

6.1.1.5 Participants' Demographic Information

A total of 901 participants from 32 different countries and five continents (see Figure 6.3) participated in the study out of which 802 valid responses were retained: their demographic information is summarized in Table 6.1. Each participant received $2 USD dollar compensation, which is within the range of the standard rates for other tasks recruited through AMT. In general, In general, a relatively diverse population was recruited in terms of gender, age, education level attained, and gamer types. On average, our participants played games a few times per week. Participants were at least 18 years old at the time of data collection. This is in compliance with the study ethics approval and to ensure that the participants were of legal age to make decisions independently (including decisions on what to eat). Participants were all computer or video game players, which ensured accurate classification and mapping to the gamer types.

For the remaining part of the thesis, I use the following phrases to represent the mapping of gamer types and intervention types used in the study:

Achiever Competition – Achievers that played the (competition version) JunkFood ALIENS-C

Achiever Reward – Achievers that played the (reward version) JunkFood ALIENS-R

Conqueror Competition – Conquerors that played the (competition version) JunkFood ALIENS-C

Conqueror Reward – Conquerors that played the (reward version) JunkFood ALIENS-R

General Competition – Participants in the general group that played the (competition version) JunkFood ALIENS-C

General Reward – Participants in the general group that played the (reward version) JunkFood ALIENS-R

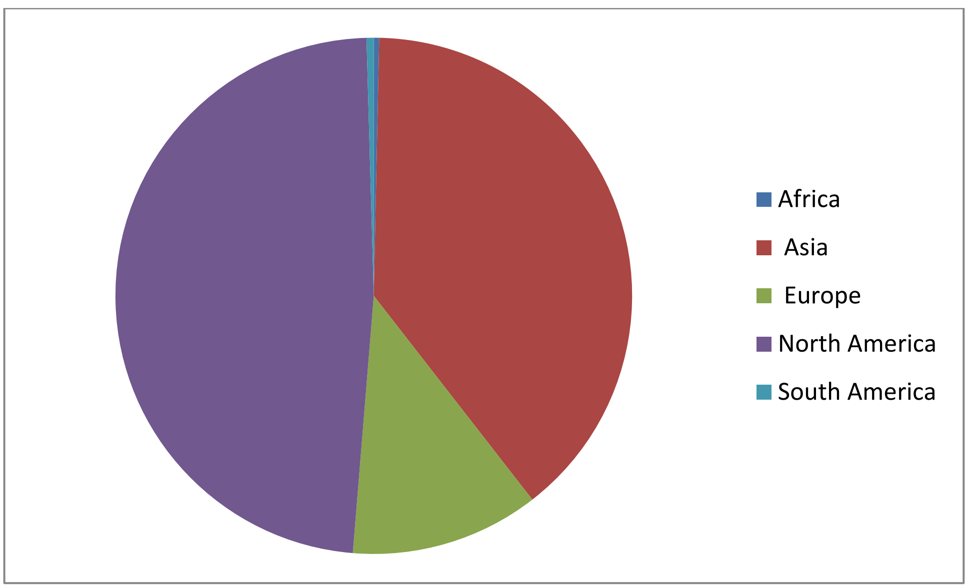


Figure 6.3: Participants Classification by Continent

Table 6.1: Participants' demographic information

Total Participants = 802		
Gender	Achiever Competition	Females (43, 46%), Males (51, 54%)
	Achiever Reward	Females (53, 53%), Males (47, 47%)
	Conqueror Competition	Females (18, 26%), Males (51, 74%)
	Conqueror Reward	Females (31, 43%), Males (41, 57%)
	General Competition	Females (95, 42%), Males (133, 58%)
	General Reward	Females (110, 46%), Males (129, 54%)
Age	Achiever Competition	18-24(25, 27%), 25-34(41, 44%), 35-44 (15, 16%), Above45 (13, 14%).
	Achiever Reward	18-24(24, 24%), 25-34(46, 46%), 35-44 (18, 18%), Above45 (12, 12%).
	Conqueror Competition	18-24 (16, 23%), 25-34 (36, 52%), 35-44 (10, 14%), Above45 (7, 10%).
	Conqueror Reward	18-24 (20, 28%), 25-34 (35, 49%), 35-44 (14, 19%), Above45 (3, 4%).
	General Competition	18-24(59, 26%), 25-34(116, 59%), 35-44 (33, 14%), Above45 (20, 9%).
	General Reward	18-24(68, 28%), 25-34(113, 47%), 35-44 (38, 16%), Above45 (20, 8%).
Education	Achiever Competition	Less than High School (2, 2%), High School Graduate (16, 17%), College Diploma (4, 4%), Bachelor's Degree (49, 52%), Master's Degree (14, 15%), Doctorate (7, 7%), Others (2, 2%).
	Achiever Reward	Less than High School (1, 1%), High School Graduate (27, 27%), College Diploma (10, 10%), Bachelor's Degree (41, 41%), Master's Degree (19, 19%), Doctorate (1, 1%), Others (1, 1%).
	Conqueror Competition	Less than High School (2, 3%), High School Graduate (14, 20%), College Diploma (10, 14%), Bachelor's Degree (28, 41%), Master's Degree (14, 20%), Others (1, 1%).
	Conqueror Reward	High School Graduate(18, 25%), College Diploma (9, 13%), Bachelor's Degree (30, 42%), Master's Degree (13, 18%), Doctorate (2, 3%).
	General Competition	Less than High School (1, 0%), High School Graduate (59, 26%), College Diploma (29, 13%), Bachelor's Degree (89, 39%), Master's Degree (43, 19%), Doctorate (3, 1%), Others (4, 2%).
	General Reward	Less than High School (2, 1%), High School Graduate (63, 26%), College Diploma (34, 14%), Bachelor's Degree (95, 40%), Master's Degree (42, 18%), Doctorate (1, 0%), Others (2, 1%).

6.1.2 Data Analysis

The main aim of this evaluation is to examine and compare the efficacy of the tailored persuasive game, the contra-tailored persuasive game, and the randomly assigned persuasive game conditions with respect to their ability to effect change in healthy eating attitude, self-efficacy, and intention. This entails examining and comparing the pre and post-intervention attitude, self-efficacy, and intention to eat healthily. To achieve this, I used several well-known analytical tools and procedures. In this section, I summarize the various steps taken to analyze the data.

- Because one of the reasons people play games is because games are fun, I started the analysis by examining the participants' overall experience playing the game and their experience playing the individual versions of JunkFood ALIENS.
- First, I compared the experience measures to a neutral rating using a one-sample t-test.
- Next, to compare the play experiences, I employed the Two-Way (Univariate) ANOVA with Gamer Type (achiever, conqueror, and general) and Intervention type (competition and reward) as between-subject factors and play experience (interest-enjoyment, perceived competence, and effort) as dependent measures.
- Following findings of significant effects, I employed the planned pairwise-comparison , using Bonferroni test for adjusting the degrees of freedom for multiple comparison, to determine the groups that significantly differ from each other with respect to the play experience subscales.
- After I examined the play experience, the next step was to examine whether playing the game actually led to a positive change in attitude, self-efficacy, and intention overall and whether the tailored persuasive game conditions are more effective than the contra-tailored and the random assigned persuasive game. To achieve this, I performed the following analysis.
- Before examining the influence of the games on attitude, self-efficacy, and intention, I examined the scales for internal consistency using reliability analysis [147]. Given the positive results, the data is suitable to proceed with analysis.
- Prior to performing an in-depth analysis on the data, I graphically examined the data using SPSS GGraph to have a general view of the trends and patterns in the data.

- Next, I employed the Repeated-Measure ANOVA with time as within-subject (pre and post), and gamer type (achiever, conqueror, and general) and intervention type (competition and reward) as between-subjects factors on the dependent measures of attitude, intention, and self-efficacy to examine whether there were significant effects of time, gamer type, and intervention on attitude, self-efficacy, and intention to eat healthily.
- Following findings of significant effects I performed a planned pairwise comparison, using Bonferroni for adjusting the degrees of freedom for multiple comparison, to determine the groups that significantly differ from each other.
- Finally, to test whether the magnitude of change in attitude, intention, and self-efficacy varied between the groups, I conducted a Univariate ANOVA with gamer type (achiever, conqueror, general) and intervention type (competition, reward) as between-subjects factors on the dependent measures of attitude change, intention change, and self-efficacy change (i.e., post-intervention – baseline).

All ANOVA were performed after validating the data for the assumptions of ANOVA.

6.1.3 Results

First, I present the results of the play experience as measured using the IMI subscales – *interest-enjoyment*, *perceived competence,* and *effort* (we will use "enjoyment", "competence" and "effort" for brevity) I then explore the effectiveness of the individual game versions with respect to the effect of time, gamer type, and intervention type. Finally, I compare the effectiveness of the tailored, contra-tailored, and the randomly assigned persuasive game condition.

6.1.3.1 Player Experience

The first question that comes to mind when evaluating any game is the play experience. In this subsection I present the results from the analyses of play experience data – interest-enjoyment, perceived competence, and effort.

6.1.3.2 Overall Experience Playing JunkFood ALIENS

Alongside examining the differences in play experience, investigating the participants' overall experience playing JunkFood ALIENS is of interest. To achieve this, I performed one-sample t-tests separately on the data from playing the different versions of the game (JunkFood ALIEN-C and

JunkFood ALIEN-R) and on the combined data to obtain an overall experience playing JunkFood ALIENS. I compared this data against an optimistic-neutral rating for IMI subscales data of 3. Figure 6.4 and Table 6.2 present the details of the overall experience playing JunkFood ALIENS.

In general, participants experienced quite high satisfaction with respect to enjoyment, competence and effort. As shown in Table 6.2 and Figure 6.4, the t-values and the corresponding mean of the individual subscales are well above the optimistic neutral rating of 3. Therefore, JunkFood ALIENS was successful at inspiring positive play experience overall.

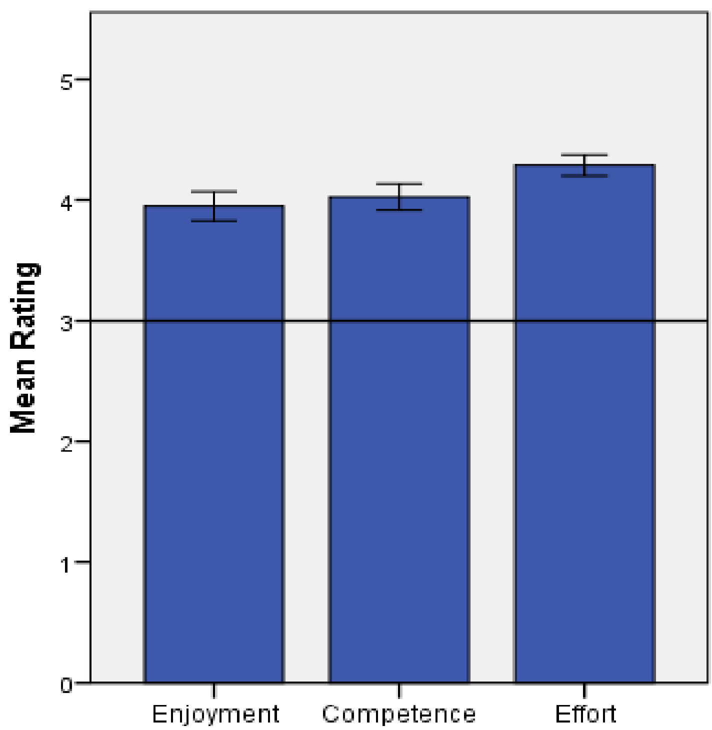


Figure 6.4: A bar graph of the mean of individual IMI subscales for the overall game play experience. Error bars represent a 95% confidence interval.

Table 6.2: Means and Standard Deviations (SD), Mean Difference (MD), t-values (t), and Significant levels (p) for Enjoyment, Competence, and Effort on a scale from 1 (low) to 5 (high) for overall play eexperience.

	N = 802				
	Mean	SD	MD	t	p
Enjoyment	3.88	1.27	0.88	19.55	<0.000
Competence	3.98	1.09	0.98	25.35	<0.000
Effort	4.12	0.95	1.12	33.50	<0.000

Similarly, participants expressed positive experience from playing the individual versions of JunkFood ALIENS with respect to the enjoyment, competence, and effort. As shown in Table 6.3, the t-values and the corresponding mean of the individual subscales resulting from playing each version are all above the optimistic neutral rating of 3 – Figure 6.5. Participants therefore had positive experience playing the two versions of JunkFood ALIENS. Since the player had positive experiences from playing both versions of JunkFood ALIENS, I next investigate whether there is any difference in play experience depending on the gamer type and the intervention type using the univariate ANOVA.

Table 6.3: Means and Standard Deviations (SD), Mean Difference (MD), t-values (t), and Significant levels (p) for Enjoyment, Competence, Effort, on a scale from 1 (low) to 5 (high) for gamers' experience playing the two game versions.

	N = 391				N = 411				
	Competition				**Reward**				
	Mean	SD	MD	t_2	Mean	SD	MD	t_2	p
Enjoyment	3.80	1.28	0.80	17.06	3.95	1.26	0.95	15.32	<0.000
Competence	3.93	1.07	0.93	19.27	4.03	1.11	1.03	18.76	<0.000
Effort	3.95	0.98	0.95	18.42	4.29	0.90	1.29	29.16	<0.000

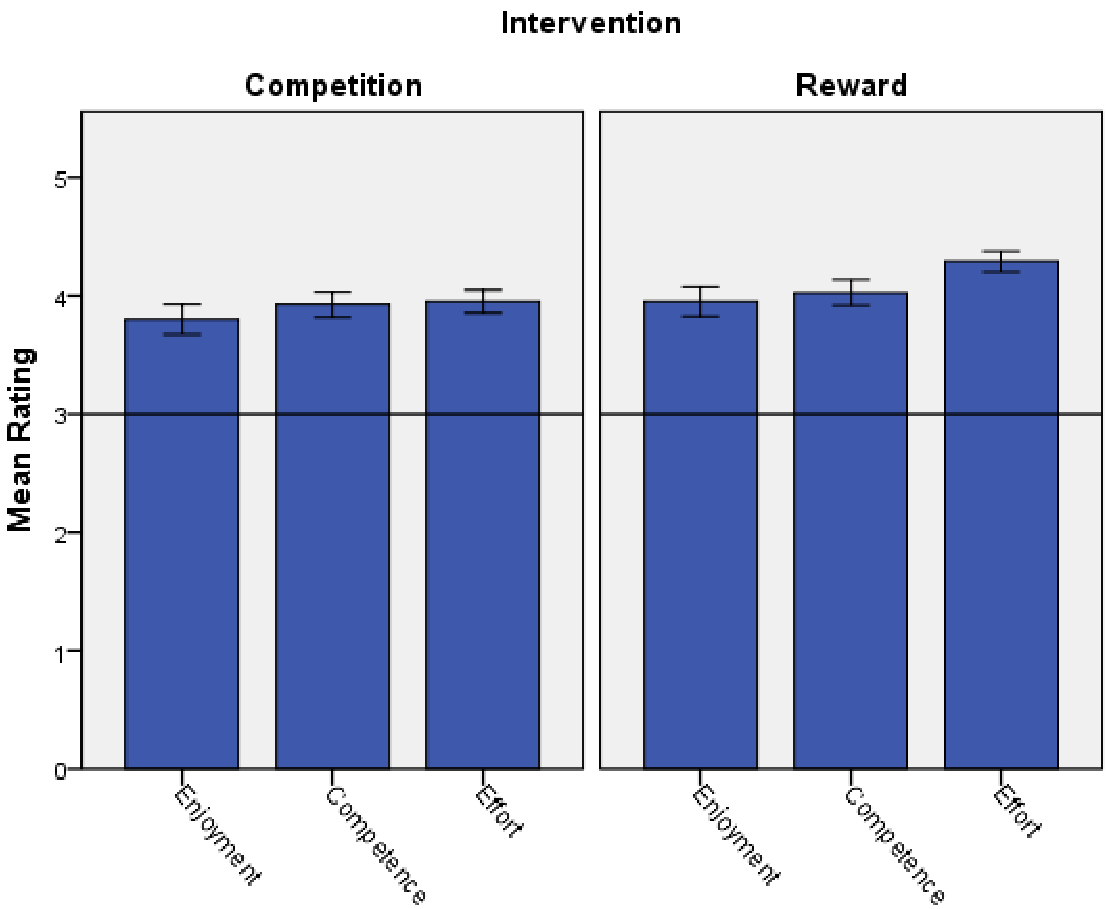


Figure 6.5: A bar graph of the mean of individual IMI subscales for the two versions of the – JunkFood ALIEN-C(Competition) and JunkFood ALIENS-R(Reward). Error bars represent a 95% confidence interval.

6.1.3.3 Examining Play Experience by Gamer Types and Intervention Type

I conduted a two-way (univariate) ANOVA with gamer type (achiever, conqueror, and general) and intervention type (competition and reward) as between-subject factors and play experience (interest-enjoyment, perceived competence, and effort) as dependent measures

Enjoyment: The results show no significant main effects of gamer type or intervention type on interest-enjoyment ($F_{2,796}$=2.211, p≈.110, η^2=.006) and ($F_{1,796}$=2.211, p≈.425, η^2=.001) respectively when considered separately, suggesting that there were no overall group differences in how gamer types enjoyed the games or the interventions. However, there was a significant interaction between gamer type and intervention type ($F_{2,796}$=3.742, p≈.024, η^2=.006). Pairwise comparison shows that achievers playing the JunkFood ALIENS-R led to higher enjoyment than playing JunkFood ALIENS-C ($F_{1,796}$=4.654, p≈.031, η^2=.006); whereas, conquerors playing the JunkFood ALIENS-C led to higher enjoyment than playing JunkFood ALIENS-R ($F_{1,796}$=2.708, p≈.100, η^2=.003); and for the general group, there was no significant difference in enjoyment between participants who played the JunkFood ALIENS-C and those who played the JunkFood ALIENS-R ($F_{1,796}$=2.951, p≈.086, η^2=.003). This result is in line with my expectations as JunkFood ALIENS-R was designed to appeal to acheivers, whereas JunkFood ALIENS-C was designed to appeal to conquerors.

Competence: Similar to enjoyment, the results show no significant main effects of gamer type or intervention type on competence ($F_{2,796}$=.900, p≈.407, η^2=.002) and ($F_{1,796}$=.494, p≈.425, η^2=.001) respectively when considered separately. However, there was a significant interaction between gamer type and intervention type ($F_{2,796}$=3.978, p≈.019, η^2=.010). Pairwise comparison shows that for achievers, playing JunkFood ALIENS-R led to higher feelings of competence than playing JunkFood ALIENS-C ($F_{1,796}$=5.860, p≈.016, η^2=.007). For conquerors, playing JunkFood ALIENS-C led to higher perceived competence than playing JunkFood ALIENS-R ($F_{1,796}$=2.693, p≈.101, η^2=.003); and for the general group, there was no significant difference in competence between participants who played JunkFood ALIENS-C and those who played JunkFood ALIENS-R ($F_{1,796}$=1.104, p≈.294, η^2=.001). Again, these results confirm our expectations about the game design.

Effort: In this case, the results show significant main effects of gamer type and intervention type on effort (F2,796=7.520, p≈.001, η2=.019) and (F1,796=27.447, p≈.000, η2=.033) respectively when considered separately. However, there was no significant interaction between gamer type and intervention type (F2,796=1.282, p≈.278, η2=.003). The pairwise comparison for the main effects shows that achievers reported investing the highest levels of effort, followed by the general group, and then conquerors. Similarly, gamers who played JunkFood ALIENS-R reported investing greater levels of effort than those who played Junk Food ALIENS-C –Figure 6.6. The descriptive statistics is as presented in Table 6.4.

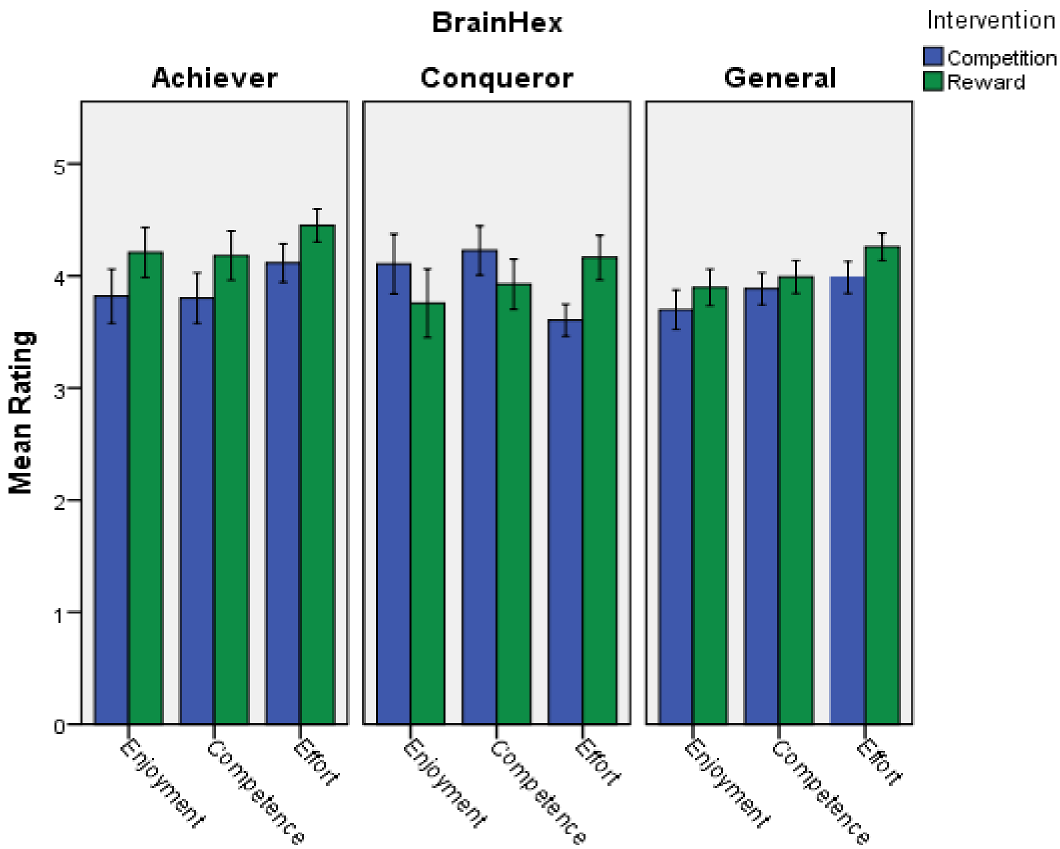


Figure 6.6: Paired mean of individual IMI subscale by intervention type. Error bars represent a 95% confidence interval.

Table 6.4: Means and Standard Deviations (SD) for Enjoyment, Competence, Effort on a scale from 1 (low) to 5 (high) by gamer type and intervention type.

	Achiever		**Conqueror**		**General**	
	Compt	Reward	Compt	Reward	Compt	Reward
	mean*(SD)*	mean*(SD)*	mean*(SD)*	mean*(SD)*	mean(*SD*)	mean*(SD)*
Enjoyment	3.82(1.18)	4.21(1.13)	4.11(1.11)	3.76(1.30)	3.70(1.35)	3.90(1.28)
Competence	3.80(1.10)	4.18(1.10)	4.23(0.92)	3.96(0.96)	3.88(1.09)	3.99(1.15)
Effort	4.11(0.83)	4.45(0.75)	3.61(0.59)	4.16(0.85)	3.99(1.09)	4.25(0.96)

6.1.3.4 Summary of Play Experience Results

In general, JunkFood ALIENS inspired a positive play experience, showing that participants enjoyed playing the game overall. With respect to the intervention type, JunkFood ALIENS-R stimulated more effort overall than JunkFood ALIENS-C. However, this did not translate to significantly heightened feeling of competence or enjoyment of the game. Therefore, players are likely not investing effort because they enjoy the JunkFood ALIENS-R more or feel more competent playing it. One possible explanation may be the algorithmic reward design mechanism employed in JunkFood ALIENS-R that increases the work required to unlock the badges as the game progresses. The earnable badges and the requirement for earning them were made visible to the players, therefore increasing players' desire to earn them. As a result, players were constantly striving to attain the required level and point to unlock the badges. This is supported by comments from participants such as *"I played longer because I really wanted to accumulate more badges and gain the highest title of a hero. I'm happy that I'm able to attain my goal of earning the highest badges possible."*

With respect to the gamer types (without considering intervention type), achievers reported the highest level of effort overall, however, similar to the intervention type, this did not translate to different ratings of perceived competence and enjoyment. This follows directly from one of the characteristics of achievers, who are known for doing everything they can to get the satisfaction of completing a task. The lack of significant effect of both intervention type and gamer type on enjoyment and perceived competence stresses the need for tailoring persuasive games.

With respect to intervention type and gamer type interactions, playing the tailored JunkFood ALIENS led to higher enjoyment and higher ratings of perceived competence than playing the contra-tailored version. Specifically, for achievers, playing JunkFood ALIENS-R led to higher enjoyment and higher ratings of perceived competence than playing JunkFood ALIENS-C. On the other hand, for conquerors, playing JunkFood ALIENS-C led to higher enjoyment and higher rating of perceived competence than playing JunkFood ALIENS-R. This shows the efficacy of tailored persuasive games to inspire better play experiences and hence more intrinsic motivation. Following from this, I investigate whether playing tailored persuasive games promoted more positive changes in attitude, self-efficacy, and healthy eating intention than contra-tailored or randomly assigned persuasive games.

6.1.3.5 Efficacy of The Persuasive Games Interventions

In this subsection, I investigate the efficacy of JunkFood ALIENS for promoting healthy eating by inspiring positive change in healthy eating attitude, self-efficacy, and intention. To achieve this, I employed RM-ANOVA with time as a within-subjects (pre and post) factor, and gamer type (achiever, conqueror, and general) and intervention type (competition and reward) as between-subjects factors on attitude, intention, and self-efficacy.

6.1.3.6 Overall effects of JunkFood ALIENS hence

Before investigating for possible differences in players' attitude, self-efficacy, and intention with respect to the gamer types and intervention types, it is necessary to establish the internal consistency of the measurement scales. The consistency of a scale is determined using Cronbach's alpha (α). As shown in Table 6.5, Cronbach's alphas are all higher than 0.70 showing that the scales have good internal consistency, therefore, I proceed with the analysis.

Table 6.5: Cronbanch alpha (α) for pre and post attitude, self-efficacy, and intention for each dataset

	Attitude		**Self-efficacy**		**Intention**	
	Pre	Post	Pre	Post	Pre	Post
Achiever Competition	.92	.93	.89	.90	.95	.97
Achiever Reward	.95	.92	.93	.92	.95	.96
Conqueror Competition	.92	.88	.95	.88	.93	.91
Conqueror Reward	.94	.94	.78	.72	.92	.95
General Competition	.92	.92	.91	.93	.94	.94
General Competition	.93	.94	.86	.89	.93	.95

Gamer Type: The results of the RM-ANOVA show no significant difference between groups – achiever, conquerors, and general – overall on any measure. Gamer type has no significant main effect on overall ratings of attitude ($F_{2,796}$=0.842, p≈.431, η^2=.002), self-efficacy ($F_{2,796}$=0.420, p≈.657, η^2=.001), or intention ($F_{2,796}$=2.192, p≈.112, η^2=.005). This means that the gamer groups did not rate their attitude, self-efficacy, and intention differently overall, establishing that there were no group-level differences in the ratings.

Intervention Type: Similar to gamer type, the results show no significant difference between the interventions – JunkFood ALIENS-C and JunkFood ALIENS-R – on any measure. Intervention type has no significant main effect on overall ratings of attitude ($F_{1,796}$=0.001, p≈.980, η^2=.000), self-efficacy ($F_{1,796}$=0.006, p≈.936, η^2=.000), and intention ($F_{1,796}$=.556, p≈.456, η^2=.001). This means that random participant assignment to the game versions did not yield groups who fundamentally rated their attitude, self-efficacy, or intention differently if all other variables are ignored. This results establishes that the random assignment to the experimental conditions was effective and did not produce bias.

Time: The results show significant main effect of time on attitude ($F_{1,796}$=123.790, p≈.000, η^2=.135), self-efficacy ($F_{1,796}$=97.480, p≈.000, η^2=.109), and intention ($F_{1,796}$=256.377, p≈.000, η^2=.224) overall. This means that there is a significant difference between the pre and post tests when all groups – gamer types and intervention type – are considered together. Attitude, self-efficacy, and intention measured immediately following game play were significantly improved from that taken before the play as shown in Figure 6.7. This means that after playing JunkFood ALIENS, participants reported an increased attitude, self-efficacy, and intention to eat healthily. The game was therefore generally successful in promoting a positive attitude, self-efficacy, and intention over all groups and intervention types. Next, I consider the interactions between intervention type and time.

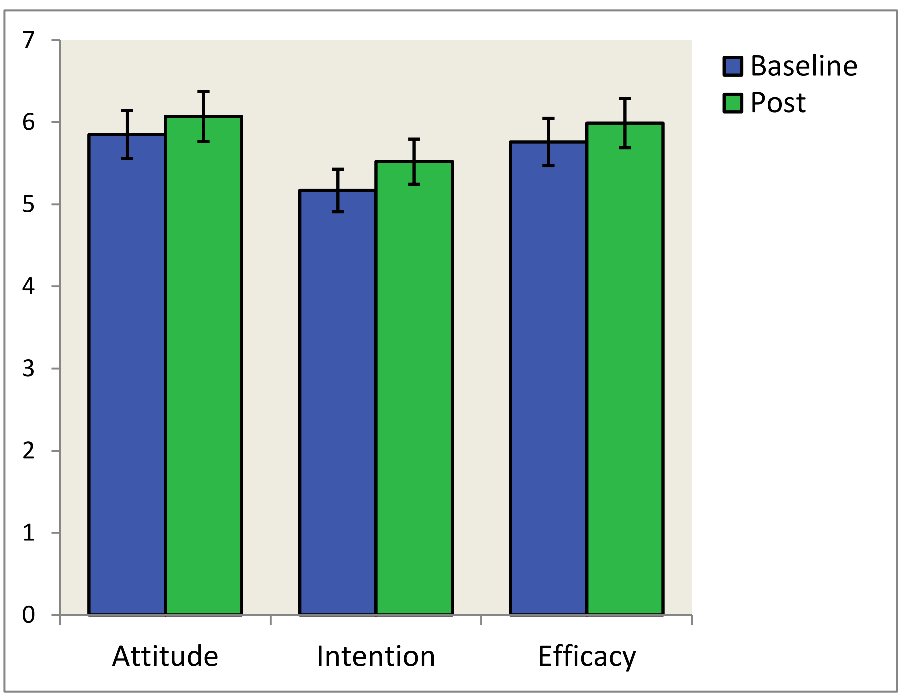


Figure 6.7: A bar graph showing the paired means of attitude, self-efficacy, and intention ratings over time –baseline and post. Error bars represent a 95% confidence interval.

6.1.3.7 Interactions between Gamer Type and Time

The results show significant interactions between gamer type and time for all the three measures – attitude ($F2,796=21.396$, $p \approx .000$, $\eta 2=.051$), self-efficacy ($F2,796=14.977$, $p \approx .000$, $\eta 2=.036$), and intention ($F1,796=43.957$, $p \approx .000$, $\eta 2=.099$). Pairwise comparison shows that playing JunkFood ALIENS promoted more positive change in all measures for conquerors and achievers than the general group, see Figure 6.8. All differences were significant at $p<.005$. These results are further explained in the 3-way interaction between gamer type, intervention type, and time.

6.1.3.8 Interactions between Intervention Type and Time

Considering the efficacy of JunkFood ALIENS for promoting positive changes in all the three measures overall, I next investigated for differences between the two versions of JunkFood ALIENS with respect to their ability to influence change in attitude, self-efficacy, and intention overtime – pre and post test.

The results showed no significant interaction between intervention type and time for all three of the measures – attitude ($F_{1,796}=0.224$, $p \approx .636$, $\eta^2=.000$), self-efficacy ($F_{1,796}=0.200$, $p \approx .655$, $\eta^2=.000$), or intention ($F_{1,796}=2.755$ $p \approx .097$, $\eta^2=.003$). This suggests that there is no difference between the competition and reward strategies in terms of their effectiveness (overall) when gamer type is ignored. Without considering gamer type, these results would suggest that the reward and competition strategies are not different in their efficacy; however, considering the 3-way interaction with gamer type shows otherwise.

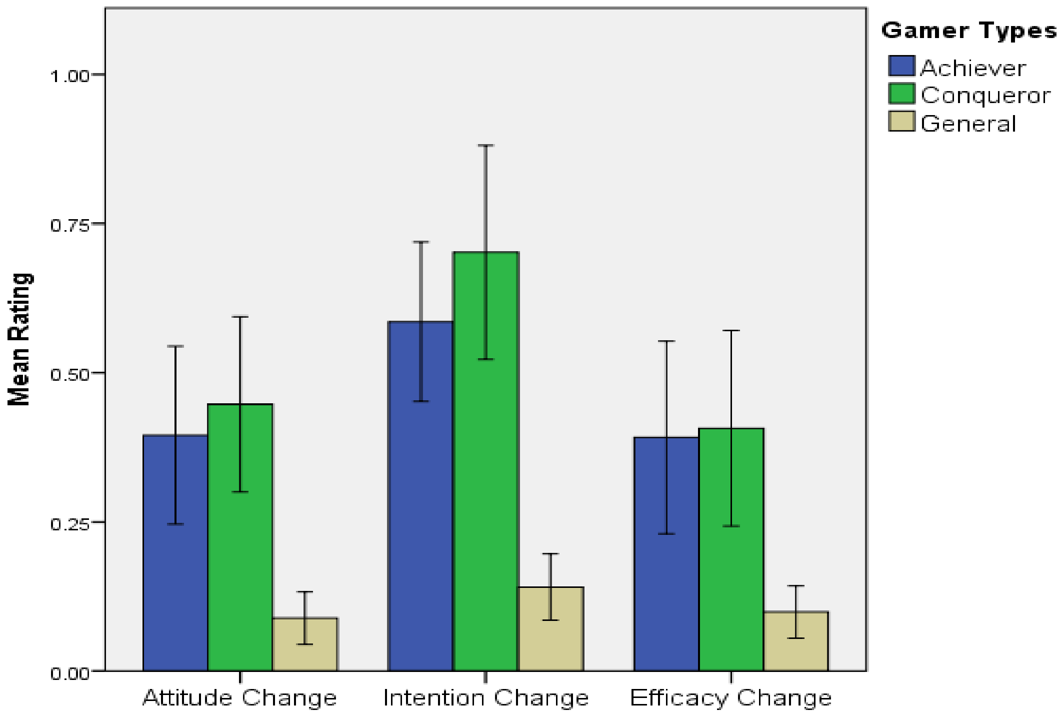


Figure 6.8: Mean change in attitude, intention, and self-efficacy over time by gamer types. Error bars represent a 95% confidence interval.

6.1.3.9 3-way Interaction between Gamer Type, Intervention Type, and Time

Thus far, we have seen results suggesting that there is no difference in the efficacy of employing a reward strategy or a competition strategy in a persuasive healthy eating game; however, the significant 3-way interaction shows the beneficial results of tailoring the persuasive game. The results show that there are significant interactions between gamer type, intervention type, and time for all the three measures – attitude ($F_{2,796}$=51.049, $p \approx .000$, η^2=.114), self-efficacy ($F_{2,796}$=37.283, $p \approx .000$, η^2=.086), and intention ($F_{1,796}$=62.497, $p \approx .000$, η^2=.136). Pairwise comparison shows that for:

Achievers: Reward was more effective than competition for all measures for achievers. Specifically, playing JunkFood ALIEN-R motivated an increase in attitude ($p \approx .000$) and self-efficacy ($p \approx .000$) towards healthy eating while playing JunkFood ALIEN-C led to no significant change in either attitude (p=.641) or self-efficacy (p=.978) for achievers, see Figures 6.9 and 6.10. For intention, although both the reward (p≈.000) and competition (p=.018) strategies were significant, the magnitude of the differences suggests that reward may have been more effective (see Figure 6.11).

Conquerors: Competition was more effective than reward for all measures for conquerors. Specifically, playing JunkFood ALIENS-C promoted positive changes in attitude (p≈.000) and self-efficacy (p≈.000) towards healthy eating while playing JunkFood ALIEN-R led to no significant change in either attitude (p=.089) or self-efficacy (p=.349) for conquerors, see Figures 6.9 and 6.10. For intention, although both the reward (p=.034) and competition (p≈.000) strategies were significant, the magnitude of the differences suggests that competition may have been more effective (see Figure 6.11).

General: For the general group, competition was more effective than reward overall. Specifically, playing JunkFood ALIEN-C promoted positive changes in attitude (p=.001) and self-efficacy (p=.034) towards healthy eating while playing JunkFood ALIEN-R led to no significant change in either attitude (p=.529) or self-efficacy (p=.057) for the general group, see Figures 6.9 and 6.10. The significant level of the changes over time for each measure by intervention type and gamer type is as summarized in Table 6.6. For intention, both the reward (p=.002) and competition (p=.002) strategies were significant, and the magnitude of the differences suggests that neither strategy was more effective (see Figure 6.11).

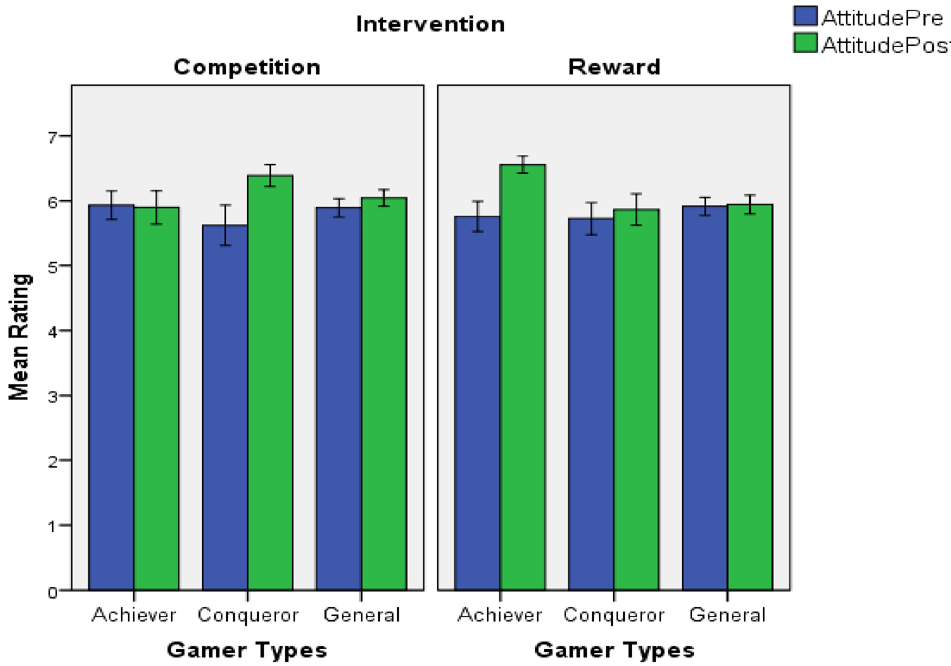


Figure 6.9: Paired means of pre and post attitude by gamer type and intervention type. Error bars represent a 95% confidence interval.

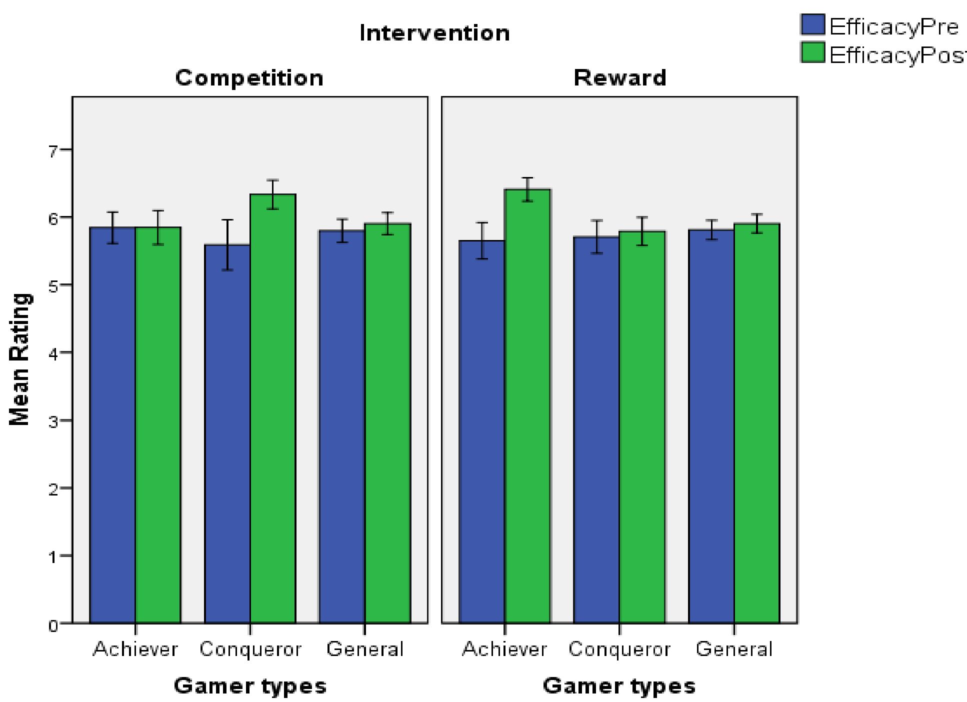


Figure 6.10: Paired means of pre and post self-efficacy by gamer type and intervention type. Error bars represent a 95% confidence interval

Table 6.6: Significant levels of the changes over time for attitude, efficacy, and intention by gamer type and intervention type. Significant level $p<0.05$.

	Achiever		Conqueror		General	
	Compt	Reward	Compt	Reward	Compt	Reward
Attitude	.641	.000	.000	.089	.001	.529
Efficacy	.978	.000	.000	.349	.034	.057
Intention	.018	.000	.000	.034	.002	.002

As shown in Table 6.6, playing both JunkFood ALIENS-C and JunkFood ALIENS-R led to significant changes in intention for all the gamer groups, but the p-values and means suggests that, perhaps, the magnitude of the effectiveness was different – see Figure 6.11. To explore this effect, and to test the magnitude of differences for attitude and self-efficacy, I performed a Univariate ANOVA on the difference (post-intervention – baseline) in attitude, self-efficacy, and intention with gamer type and intervention type as between-subjects factors.

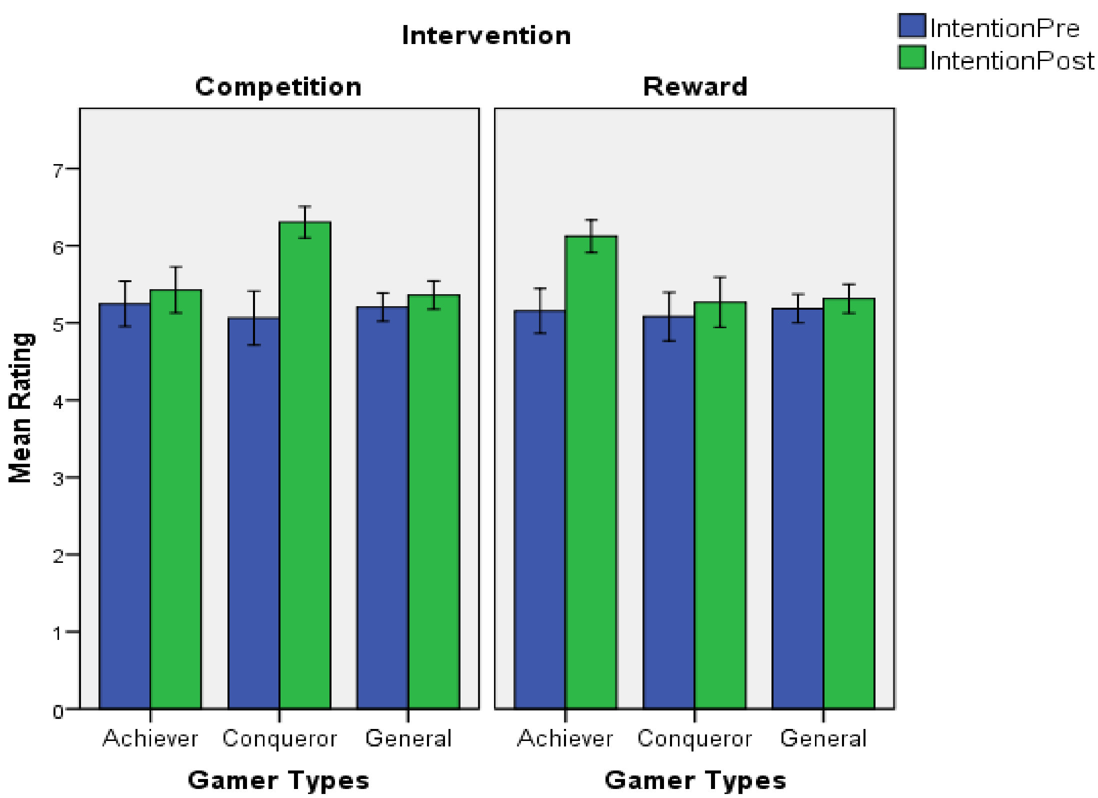


Figure 6.11: Paired means of pre and post intention by gamer type and intervention type. Error bars represent a 95% confidence interval.

6.1.3.10 Univariate ANOVA with Gamer Type and Intervention Type as between-subjects factors on Behaviour Change Measures.

To test the magnitude of differences for attitude, self-efficacy, and intention , I performed a Univariate ANOVA with Gamer Type (Achiever, Conqueror, General) and Intervention Type (Competition, Reward) as between-subjects factors on Attitude Change, Intention Change and Efficacy Change.

Attitude Change: The results of the univariate ANOVA show a significant main effect of gamer type on attitude change ($F_{2,\ 796}$=21.396, p≈.000, η^2=.051). Confirming prior results, the pairwise comparisons show that the general group is less affected by the intervention than Achievers or Conquerors (see Figure 6.12). There was no significant intervention type effect on attitude ($F_{1,796}$=224, p≈.636, η^2=.000), suggesting that there was no difference between the competition and reward strategies; however, the significant interaction between gamer type and intervention type ($F_{2,796}$=51.049, p≈.000, η^2=.114) reinforces the need to tailor persuasive games. Pairwise comparisons show that Achievers playing JunkFood ALIENS-R experienced greater attitude change than those playing JunkFood ALIENS-C ($F_{1,796}$=69.587, p≈.000, η^2=.080); for Conquerors, playing JunkFood ALIENS-C motivated a positive change in attitude, whereas playing JunkFood ALIENS-R did not ($F_{1,796}$=28.896, p≈.000, η^2=.035); and for the General group, there was no significant difference between the participants that played JunkFood ALIENS-C and those that played JunkFood ALIENS-R with respect to attitude change ($F_{1,796}$=3.751, p≈.053, η^2=.005), see Figure 6.12.

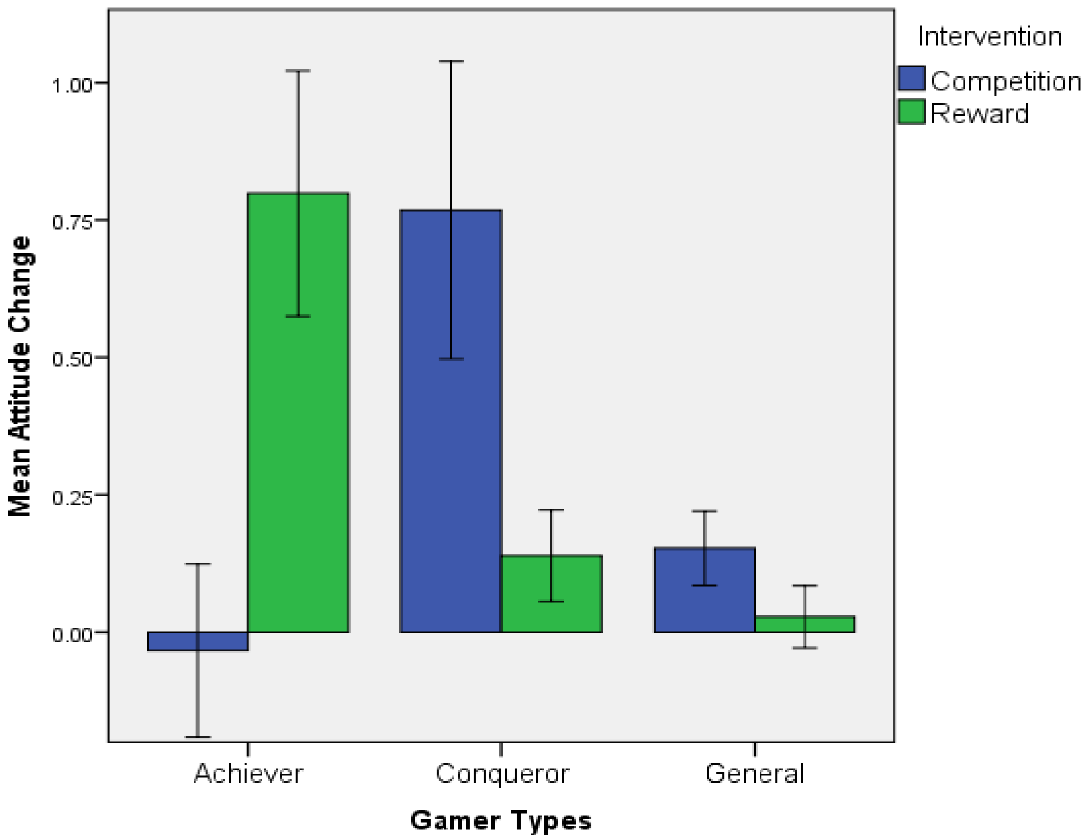


Figure 6.12: Attitude Change over time – pre to post –by intervention type and gamer type. Error bars represent a 95% confidence interval.

Self-efficacy Change: The results show a significant main effect of gamer type on self-efficacy change ($F_{2,796}$=14.977, p≈.000, η^2=.036). Pairwise comparisons show that similar to the results for attitude, the general group is less affected by the intervention than achievers or conquerors with respect to self-efficacy change (See Figure 6.13) There was no significant intervention type effect on self-efficacy ($F_{1,796}$=.200, p≈.655, η^2=.000). This again reinforces the need to tailor persuasive games because there was a significant interaction between gamer type and intervention type ($F_{2,796}$=37.283, p≈.000, η^2=.0.86). Pairwise comparisons show that achievers playing JunkFood ALIENS-R experienced greater self-efficacy change ($F_{1,796}$=48.645, p≈.000, η^2=.058) than those playing JunkFood ALIENS-C; on the other hand, for Conquerors, playing JunkFood ALIENS-C motivated higher positive change in self-efficacy ($F_{1,796}$=28.896, p≈.000, η^2=.035) than playing JunkFood ALIENS-R; and for the general group the difference between the participants that played JunkFood

ALIENS-C and those that played JunkFood ALIENS-R was not significant with respect to self-efficacy change ($F_{1,796}$=0.036, p≈.850, η^2=.000), see Figure 6.14.

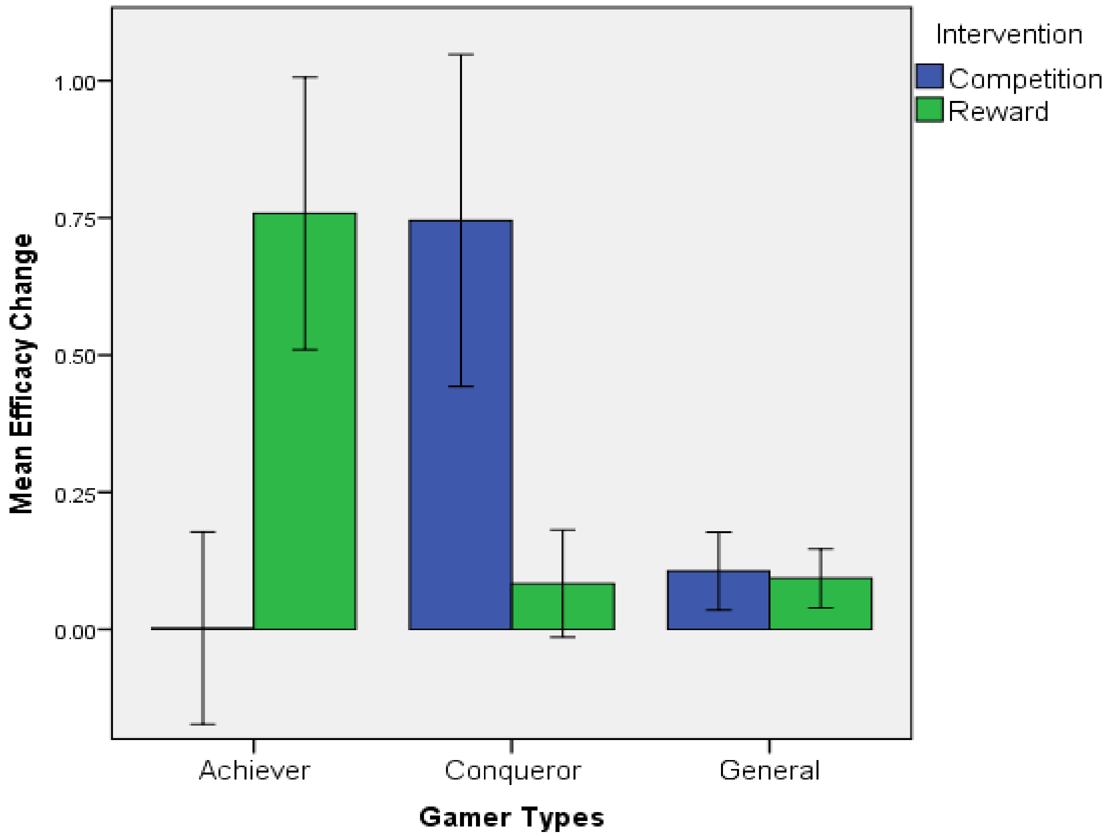


Figure 6.13: Self-efficacy Change over time – pre to post –by intervention type and by gamer type. Error bars represent a 95% confidence interval.

Intention Change: Similar to attitude and self-efficacy, the results show a significant main effect of gamer type on intention to change ($F_{2,796}$=43.957, p≈.000, η^2=.099). Pairwise comparisons show that again the general group is less affected by the intervention than achievers or conquerors with respect to intention change (See Figure 6.14). There was no significant intervention type effect on intention ($F_{1,796}$=2.755, p≈.097, η^2=.003), again reinforcing the need to tailor persuasive games because of the significant interaction between gamer type and intervention type ($F_{2,796}$=64.497, p≈.000, η^2=.136). Pairwise comparisons show that for achievers, playing JunkFood ALIENS-R led to higher intention change ($F_{1,796}$=54.004, p≈.000, η^2=.064) than playing JunkFood ALIENS-C; on the other hand, for conquerors, playing JunkFood ALIENS-C motivated a heightened change in intention

($F_{1,796}$=70.886, p≈.000, η^2=.082) than playing JunkFood ALIENS-R; and for the general group, the difference between participants that played JunkFood ALIENS-C and those that played JunkFood ALIENS-R was not significant with respect to intention change ($F_{1,796}$=.148, p≈.701, η^2=.000), see Figure 6.15. So, although both achievers and conquerors experienced intention to change as a result of playing either JunkFood ALIENS-R or JunkFood ALIENS-C, the magnitude of that intention change was greater when the intervention type was chosen according to the results from the model (described in Section 4.5).

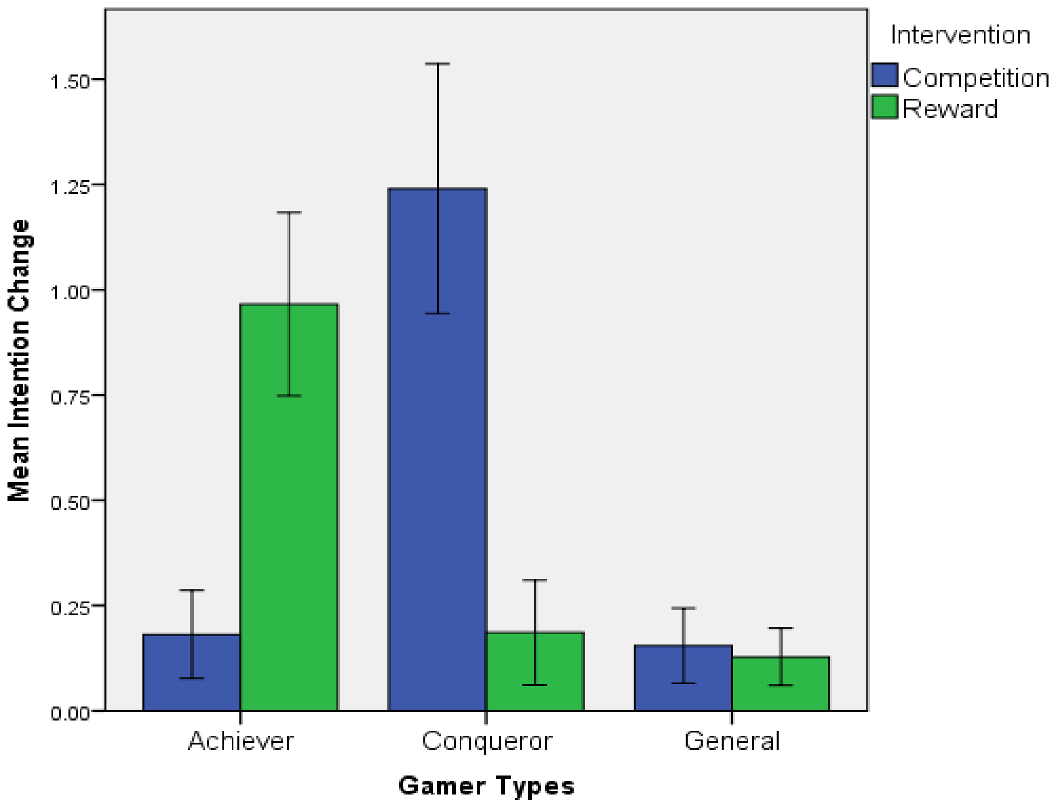


Figure 6.14: Intention Change over time – pre to post –by intervention type and gamer type. Error bars represent a 95% confidence interval.

Table 6.7 summarizes the mean and standard deviation of the changes in attitude, self-efficacy, and intention. It is worth noting that for achievers, playing JunkFood ALIENS-C led to a negative mean change in attitude over time (of -0.33) and no change in self-efficacy over time (of 0.00). This suggests a possible detrimental effect of contra-tailored persuasive game intervention.

Table 6.7: Means and SD for attitude change, self-efficacy change (efficacy change), and intention change over time – pre to post.

	Achiever		**Conqueror**		**General**	
	Compt	Reward	Compt	Reward	Compt	Reward
	mean*(SD)*	mean*(SD)*	mean*(SD)*	mean*(SD)*	mean*(SD)*	mean*(SD)*
Attitude Change	**-0.33(0.77)**	0.80(1.12)	0.77(1.13)	0.14(0.95)	0.15(0.52)	0.03 (0.44)
Efficacy Change	**0.00(0.86)**	0.76(1.25)	0.75(1.26)	0.08(0.42)	0.11(0.42)	0.09(0.42)
Intention Change	0.18(0.51)	0.97(1.09)	1.24(1.23)	0.19(0.53)	0.16(0.68)	0.13(0.53)

6.1.4 Summary of the Quantitative Results

In general, JunkFood ALIENS inspired a positive play experience, showing that participants enjoyed playing the game overall. However, playing the tailored JunkFood ALIENS led to higher enjoyment and higher ratings of perceived competence than playing both the randomly assigned version and the contra-tailored version of JunkFood ALIENS. This shows the efficacy of tailored persuasive games to inspire better play experience.

Similarly, considering the efficacy of JunkFood ALIENS to motivate behaviour change, playing JunkFood ALIENS improved attitude, self-efficacy, and intention overall. This shows the efficacy of persuasive game as a tool for motivating healthy behaviour change in general. However, a detailed analysis of the 3-way interactions between gamer type, intervention type, and time reveal that the tailored persuasive games are more effective than both the randomly assigned persuasive game and the contra-tailored persuasive games, which had the least positive effect on the participants – this is in line with the models' prediction (see Chapter 4, Section 4.5), which informed the game design.
Also according to the models presented in Chapter 4, achievers are receptive to reward ($\beta = .10$) while competition and comparison showed no significant relationship with achievers. This means that games designed using reward (tailored version for achievers) are expected to be more effective for motivating behaviour change for achievers than games designed using competition and comparison (contra-tailored). Just as predicted by the models, the results from the evaluation of the two versions of JunkFood ALIENS show that for achievers, playing JunkFood ALIENS-R (tailored version) led to significant changes in attitude and self-efficacy, whereas playing JunkFood ALIENS-C (contra-tailored version) did not. This is exactly as predicted by the models, see Chapter 4, Section 4.5. In addition JunkFood ALIENS-R (tailored version) led to a greater change in intention than

playing JunkFood ALIENS-C (contra-tailored version) for achievers – this is still in line with the models' prediction. Similarly, for conquerors, my models predicted that they are receptive to competition and comparison (β = .25) while reward showed no significant relationship with the conquerors, see see Chapter 4, Section 4.5. This means that games designed using competition and comparison (tailored to conquerors) are expected to be more effective for motivating behaviour change for conquerors than games designed using reward (contra-tailored). Again, just as predicted by the models, playing JunkFood ALIENS-C (tailored version) led to a heightened increase in attitude and self-efficacy for conquerors, whereas playing JunkFood ALIENS-R (contra-tailored version) did not. Also, intention to change was greater after playing the tailored version than the contra-tailored version – this is still in line with the models' prediction. Finally, the models predicted that competition and comparison strategy is perceived as more persuasive than reward by the majority of gamer types. Specifically, competition and comparison is significantly and positively associated with five out of the seven gamer types while reward is significantly and positively associated with one out of the seven gamer types, see Chapter 4, Section 4.5. This means that game designed using competition and comparison is expected to be more effective at motivating behaviour change than that designed using reward in a general group according to the models. Please, note that without considering gamer type, both JunkFood ALIENS-C and JunkFood ALIENS-R looked equally effective (there was no difference) – that is because the differences seen in each gamer type were being averaged out. Therefore, in line with the models' predictions, when considering gamer type, it became clear that there are differences between competition and comparison and reward for differenty types of gamers.

6.2 The Follow-up Study

The quantitative outcomes motivated follow-up research to look for explanatory results and to gain deeper insights of the dynamics of the gamer types' in-game behaviours that may have led to differential effectiveness and enjoyment of the different game versions. In this section, I report the result of a follow-up study.

6.2.1 Study Method

To understand and compare the in-game behaviour of the gamer types and their perception of the individual strategies incorporated into the JunkFood ALIENS, I conducted a follow-up study with 6 participants – 3 Achievers and 3 Conquerors. I also examined the qualitative comments about the games provided by the participants in the post survey completed immediately following game play to gain further insights. I included the qualitative comments to tease out further subtleties of the participants' preference with regards to the game features. I was especially interested in obtaining some insight about people's opinion of the PT strategies, which is the only differentiator between the two versions.

Specifically, I ran a supplementary follow-up study on both versions of Junk Food ALIENS using the think-aloud approach. The think aloud approach is a common method for usability testing used to obtain insight into user experience [124]. The method entails having users verbalize their thoughts, actions, and expectations as they use an application to perform certain tasks. By unobstructively observing the user, the test administrator can monitor, identify, and analyze the user's in-task behaviours and deviations in the user's task flow from the ideal task flow [112]. The study involved six players, half of which were achiever type and I assigned the following identifications to them A1, A2, and A3. The other half were conquerors with the following identifications C1, C2, and C3. The participants in the follow-up study were all university students between the ages of 18 to 35 and played games at least once in a month. Three of the participants were assigned to play the JunkFood ALIENS-C (A3, C1, and C2) and the other three were assigned to play the JunkFood ALIENS-R (A1, A2, and C3).

Before beginning the study, each participant was given a brief summary of the think aloud approach and asked to play the game for at least 10 minutes after they have completed the pre-test. The administrators observed and recorded each think aloud session. Below, I discuss the findings from the think-aloud sessions. Specifically, I discuss the differences in players' behaviours, perceptions and reactions in the game under three main headings: Engagement and excitement, Time commitment and enjoyment, and Educational and motivational.

6.2.1.1 Results from the Follow-up Study

In general, participants who played the tailored persuasive game showed more excitement and commitment while playing the game. They paid specific attention to the strategies. Playing the tailored version seems to focus players attention on the message of the game. Below, I expand these themes:

Engaged and Excited about the Game Strategies: Participants who played their tailored game version showed more excitement while playing the game. For example, C2 who played the tailored game believed that one of the contestants in the competition was his friend and took a snapshot of his rankings in the leaderboard each time it appeared. He continuously screamed and sometimes jumped up from his seat in excitement each time he was ranked as the top player in the leaderboard. Similarly, A2 who also played the tailored game version spent the most time playing the game because of her desire to earn the highest number of badges and become a hero. She took a snapshot of her achievements – badges and title –and shared the snapshot of her achievements with some of her friends with the caption *"I'm Damn Too Good".* The sharing of snapshots tends to support Wang's finding that *"game players rarely play alone. Even users of single player games tend to share their experiences and compare achievements with others."* [191]. However, there is a difference between the sharing of an individual achievement and explicitly being involved in a competitive game that is characterized by mutually exclusive winning. A2 also related that the most captivating aspects of the game was its ability to provide her with the knowledge of all possible rewards and what is required to unlock them. *"I was able to visualize and anticipate the rewards and that made the game really fun and exciting"* [2].. This supports Wang's assertion that reward mechanisms that give players knowledge of what is specifically required to earn them can be used to enhance feelings of fun in video games long before rewards are actually earned [191].

A1 who also played the tailored game shared similar opinions about the excitement and curiosity raised by the visible details of achievable rewards. The excitement and enjoyment of the competition and the reward strategy in the tailored condition was also confirmed by comments from participants who played the tailored game condition. Many of the participants that played the tailored condition highlighted the strategies as one of the features they enjoyed most in the game. Below are some of the comments from achievers in the tailored condition:

- *"The badges for sure is the best feature. Just tried to accumulate more points and earn the hero."*

[2] Quotes from participants are included verbatim throughout this chapter, including spelling and grammatical mistakes.

- *"The added benefit of collecting hearts falling from healthy food for points was an interesting spin on the game. It actually added a level of difficulty by forcing me to quickly decide whether it was a heart being dropped or the cholesterol and take appropriate action. I enjoyed that very much!"*
- *"I enjoyed shooting the 30 points cluster of healthy food, I also enjoyed getting the nutritious heart for +5 points and earning the achievement badges."*
- *"It was a fun game but having to get the junk food out of the way of good food was kind of a bummer there was a lot of junk food, so lost a lot of points trying to shoot them out of the way of the good food"*

The last comment suggests that achievers may not only care about activities that give them points within the game, but are also irritated by features that make them lose their achievements points.

Below are some of the comments from the conquerors who played the tailored condition:

- *"This is awesome, the struggle between the junks and good foods was interesting. The competition in the Leaderboard was definitely the best though, was up for winning all the time"*
- *"I enjoyed the leaderboard, comparing my performance with that of other players. Really wished I was good enough to beat other folks!!! Meanwhile, the bullet from the junk food had no mercy on me, bitch!!!"*
- *"Displaying ranks and scores after every round was great! I played and waited for the end of each round with excitement. It made me feel competent and I looked for every opportunity to increase my score and hence my rank"*
- *"The competition was cool, I had good fighters!"*
- "*The score and the competition were awesome. I performed really well, the assholes were good though, but I trusted myself to beat the hell out of them* "

The contra-tailored condition participant – C3 – was somehow indifferent about the reward mechanism. However, he expressed his likeness for the game especially with regards to some competition-like features: *"The positive reinforcement of the healthy food sending heart as* *nutrient, and the unhealthy food sending the graphic image that looks like cholesterol that took away points and functions as negative reinforce was a good concept. It's like a competition between healthy and unhealthy food".* To further stress his inclination for competitive games, C3 gave this comment after completing the game *"The game needs to be improved so that it engages player better, I wanna compete with others!!! I'm damn good at this..."* Similarly, A3 (who also played the contra-tailored condition) did not make any reference to the competition strategy when asked about the features of the game he enjoyed rather, he pointed out reward and achievements related features. " *I just like the hearts from those healthy foods and the superfood that gives 30 points. The junk foods were so brutal, scattering my defense wall and squeezing the life out of me. Got killed a couple of times, really felt sick of the junk, they're just so many in number. I just want to kill all of them and eliminate them from the earth. My family eats lots of it, I'm not happy!*" These comments from the contra-tailored condition participants is particularly interesting, it shows that this player was able to link the game activity to real world junk food eating behaviour which is a necessary step towards transferring experience from games (in-game learning) to real word behaviour change. Therefore, it reinforces that persuasive games can be strategically designed to influence behaviour in real world. It also supports the hypothesis that achievers are more inclined to rewards while conquerors are more inclined to competition.

Time Commitment and Enjoyment: The participants A1, A2, C1, and C2 who played their tailored versions of the JunkFood ALIENS were more captivated by the game and therefore, spent more time than required by the study. A2 spent over 20 minutes playing the game – double of the time required by the study – while A1, C1, and C2 spent 16, 16, and 18 minutes respectively in the game. On the other hand, the participants who played the contra-tailored version spent just about the time required by the study in playing the game – C3 spent 12 minutes and A3 spent exactly 10 minutes (less than the time spent by the participants who played the tailored version). For the participants who played the tailored versions, the major motivation was their interest in earning badges or wining the competitions for achievers and conquerors respectively. For example, according to A2 *"I played longer because I really wanted to accumulate more badges and gain the highest title of a hero. I'm happy that I'm able to attain my goal of earning the highest badges possible."* A1 shared similar opinions *"I was just curious of what the Hero honor looks like and hoped to achieve it, unfortunately, level 3 was very difficult that I couldn't unlock the*

Hero at this time. This game is addictive but I had to stop". C2 and C1 who played the tailored competition version also shared similar opinions. According to C2 *"I saw one of my buddy who was also playing. "Name" was pretty good! He gave me a tough time, so I played longer to redeem myself... I was on top of it finally – really had fun."* On the contrary, participants who played the contra-tailored version do not seem to be captivated by the game strategies and some appeared to be irritated by the strategies. For example, A3 who played the JunkFood ALIENS-C became annoyed with the competition strategy especially when it appeared that she was being outperformed by other players. She related after the game how she was particularly upset by the fact that she had to compete with others. For her, *"there is no need for the competition because eating is more of an individual decision and I don't care how others are doing...I would prefer the game without the leaderboard."* Contrary to A3's comment, C3 who played the JunkFood ALIENS-R said *"The game is good but I would have loved to see other players' performances.. making it a multiplayer and competitive game will be an interesting spin on the game."* The various reactions show that there is a relationship between tailoring persuasive strategies and persuasive game enjoyment and commitment. Hence, the idea that games are captivating could be mediated by the ability to tailor the strategies employed in the game to the appropriate audience.

Educational, Motivational, and Fun: Playing the tailored persuasive games helped focus players' attention on the messages of the game. Because of their interest in acquiring more points to either increase their ranks in the leaderboard or to unlock the badges, participants paid more attention to the messages of the game. For example, A1 and C2, who played the tailored condition, paused a number of times while playing the game and took a closer look at the arrays of foods and the game rules to differentiate between junk and healthy food. C2 found it really hard to believe that chocolate was shooting cholesterol instead of nutrients. After shouting out to the chocolate to stop shooting the poisonous bullets, he turned to the administrator and told her that the design is wrong, that chocolate is a healthy food and should release the heart. His curiosity led him to pause the game for some seconds to research on the nutritional contents of chocolate before he finally agreed that it should be classified as an unhealthy food. At the end of the game, most of the participants agreed that the game was fun and educational with comments such as *"Fun game and at the same time educational". "It was a fun take on space invader classic. I did not realize right away that the fruits/veggies were giving hearts which was a cool add on."* However, C3 – who played the contra-tailored condition – saw the game as a good tool for educating kids (as opposed to adults) about unhealthy foods and the adverse effect of consuming them – "*It made for a fun hit and is probably a great way to teach kids about unhealthy food and the dangers of consuming them*".

In summary, participants who played their tailored persuasive game version, enjoyed it, accepted the strategies, and felt excited about their game version, whereas the participants in the contra-tailored condition were sometimes indifferent or annoyed by some of the game features. Although, the prototype persuasive game is targeted at eating behaviour, the persuasive strategies and gamers' preferences for them were not specific to the study domain as participants reacted mostly to the specific strategies themselves as opposed to the domain specific contents of the game.

6.3 Discussion

The results from the evaluations demonstrate that the JunkFood ALIENS game is an effective tool for influencing positive attitude, self-efficacy, and intention to change, which are variables that mediate actual behaviour change. Compared to the random assignment condition and the contra-tailored condition, participants who played their tailored versions of the games had greater positive attitude change, self-efficacy change, and intention change. Specifically the contra-tailored group shows no significant changes in attitude and self-efficacy and in some cases a zero or negative mean change over time. These results suggest that for persuasive games to achieve their intended objective of promoting behaviour change, it is necessary to tailor the games to various gamer types using their persuasive profile presented in Chapter 4. In fact, without appropriate tailoring, persuasive games may just be another tool that might not be useful to the target audience – have no positive impact – or, in the worst case scenario, might be detrimental to the user by demotivating behaviour performance (as shown by negative mean change in attitude in Table 6.7). Here I highlight some specific insights from the evaluations that could serve as a guide for designing effective persuasive health games.

6.4 Insights for Designing Persuasive Games

Although the games were designed to test the effectiveness of tailoring interventions, deploying and evaluating this persuasive health game with so many individuals highlighted some important lessons for the design of persuasive health games in general.

Tailor persuasive games to increase their effectiveness: The results from the evaluations have effectively demonstrated that tailoring can increase the effectiveness of persuasive games at motivating healthy attitude, self-efficacy, and intention to change. One of the drawbacks of tailoring persuasive game intervention is the cost – the level of work involved in designing/adapting persuasive games for each gamer type. There are two different ways that persuasive games can be tailored using appropriate persuasive strategies. The first way is to design each game version from scratch (but this would involve a lot of work) and the second it to incorporate the persuasive strategies on top of existing games to make them appropriate for the target gamer type(s). The results from the design and evaluation of the two versions of JunkFood ALIENS shows that game designers do not have to design each game version from scratch to adapt it to the target audience. Tailoring can easily be achieved by incorporating appropriate PT strategies into existing games. For example, there is a big difference between designing a competitive game from scratch and adding competition features (e.g., global leaderboard) to existing persuasive games (just as illustrated in the design of JunkFood ALIENS-C in Chapter 5). The success of tailored JunkFood ALIENS shows a great promise and future for using tailored persuasive games as a tool for promoting healthy behaviour. As described in Chapter 5, the only difference between the two versions of JunkFood ALIENS is the use of reward – badges – in one, and the competition – global leaderboard – in the other. This implies that existing persuasive games can easily be adapted to suit the target audience by incorporating appropriate persuasive strategies following the persuasive profiles presented in see Chapter 4, Section 4.5.

Interval versus continuous display of strategies and player-control mechanism for pausing of games: From the literature, it is common for persuasive game intervention designers to display the PT strategies (e.g., leaderboard) continuously on the game panel as the game progresses. However, due to the make-and-feel/simulated competition in the JunkFood ALIENS-C, I designed a separate intervention page which appears after every interval (specifically one minute) with the appropriate player's performance measure – either the leaderboard or a collection of badges earned depending on the game version. Initially, I was not sure how players would react to this design decision; however, the result of the evaluations suggests that players enjoyed the interval performance display because it added some level of curiosity and allowed them some time to review, reflect on their performance, and restrategize. This is supported by comments such as *"Displaying ranks and scores after every round was great! I played and waited for the end of each round with excitement. It made me feel competent and I looked for every opportunity to increase my score and hence my rank."*

The interval display mechanism helped eliminate the problem with managing players' attention that is usually an issue in persuasive games [110]. Persuasive game designers often battle with how to design persuasive games to manage players' attention and direct them to certain game features which often contains important persuasive information. Players tend to focus their attention solely on playing the games, therefore ignoring the motivational strategies. The results from the evaluation of JunkFood ALIENS suggest that one way of managing players' attention is to employ a strategy of displaying PT content in intervals. This automatically focuses players' attention to the desired features and allows them to review the strategies as required. This is supported by the comments such as *"I really like that the game pauses and display my earned badges after every interval. It gives me time to rest and refresh after facing the unending firing and killing by the brutal unhealthy foods."* This comment also suggested that providing player-controlled mechanisms that allow players to pause the game and resume whenever they want – without restarting from the beginning – may be a desirable feature of persuasive games. It is important to highlight that this type of optional player-control mechanism may not be effective for focusing players' attention to certain game features because players can choose to ignore it. The automatic display that comes after an interval is more appropriate for this. However, automatically displaying the strategies may not completely ensure that players will pay attention to the information presented. One way of ensuring that players will pay attention to the presented information is to request that players perform certain tasks that will require them to pay closer attention to the information each time the strategy is presented. For example, JunkFood ALIENS required the participants to record their ranks, levels, and scores, or the scores, the highest badge earned, and their levels – which required the participants to take a closer look at the information presented – depending on whether they played in the competition or the reward version. However, it is important to note that some players did not like being asked to record or perform other tasks while playing the game and that leads to the next recommendation.

Avoid using too many pop-ups in persuasive games: As described above, JunkFood ALIENS paused and automatically displayed the intervention page after every interval. The display of the intervention page appeared like a pop-up block on the game panel, which annoyed some players as shown by comments such as:

- *"Was kind of annoying, actively playing and enjoying the game, only to have the scoreboard suddenly pop up";*
- *"The game seemed to pop up leaderboard quite often"; and*
- *"The game stopping every minute and having to record the scores was kind of irritating."*

Some game players are used to conventional game – non-persuasive games – with the main aim of enhancing the feeling of fun. Therefore, they did not appreciate a deviation from their experience in conventional games. However, persuasive games need to include mechanisms to consciously draw players' attention to the motivational contents of the games, which is their major distinguishing feature. One way of balancing the tension between focusing players' attention on certain features and overwhelming them with frequent pop-ups and demands to perform additional tasks is to employ a *hybrid approach*. The hybrid approach would combine both the interval and continuous display of important features. However, as opposed to displaying the features at a fixed short interval (e.g., each minute as in the case of JunkFood ALIENS), they could be displayed less frequently (e.g., every 3 or 4 minutes) or displayed at times that make sense in the content of the game play (e.g., after clearing a level). The combination would ensure that every player has the opportunity of capturing the important information contained in the game without feeling overwhelmed or interrupted.

For persuasive games for health, the simpler the better: Because of the nature with which persuasive game designers decide on the appropriate strategies to employ in persuasive game design (guess work), it is a common practice for persuasive game designers to employ many PT strategies in their game design. This is often done with the hope that at least one of the strategies will appeal to the target audience. The direct result of this is a complex persuasive game, with potentially overwhelming features and messages. The results from the evaluation of JunkFood ALIENS, suggests that simplicity is a desirable feature that may differentiate effective persuasive games from ineffective ones. All the participants in the follow-up evaluation explicitly highlighted the simple nature of the game as one of the things they enjoyed most. Similarly, comments relating to the games being simple are among the common desirable qualities listed by the participants in the quantitative evaluation:

- *"It is easy to learn how to play";*
- *"It had that old style game feel! Most games now can get too animated and overwhelmed with special effects";*
- *"The game is very interesting and easy"*
- *"The game is very addictive and easy to control"*
- *"I like it because it was very similar to Space Invader. It was very easy to control with the mouse"*

These reactions support the finding by Khaled et al. [110], that having too many features in a persuasive game screen overwhelmed participants and led to cognitive overload. This suggests the need for designers to resist the temptation of using excessive animations and too many strategies in a single persuasive game design and to keep persuasive games simple. This would not only attract broader audiences [77] but would eliminate the tendency of overwhelming players [110] and focus players' attention to the important contents of the game.

Be mindful of using action game that involves killing as a persuasive game for health: JunkFood ALIENS as described in Chapter 5 is a fixed-shooter game that involves players shooting and destroying junk foods. However, the junk foods attack players back by releases cholesterol and transfats as poisonous bullets which destroys the player's avatar and make it lose a life each time they are hit. This is one of the ways that JunkFood ALIENS demonstrates the adverse effect of unhealthy eating. However, some players felt really uncomfortable with this as can be seen from comments such as:

- *"Wish I would have had a moment of invulnerability after dying because I got killed 3 times in a row very quickly by the same enemies. I finished the game feeling really weak and sick!"*
- *"The "death" sequence needs to be changed so that I don't have to "insta-die" again with another collision upon respawn"*
- *"The premise was nice, but shields should be stronger to withstand the fire from the junk food and the rate at which I can fire increased"*
- *"The junk foods were so brutal, scattering my defense wall and squeezing the life out of me. Got killed a couple of times, really felt sick of the junk, they're just so many in number. I just want to kill all of them and eliminate them from the earth..."*
- *"I just like the healthy food "*

These reactions suggest that people perceive persuasive game for health differently from conventional action games that often involve battling with enemies. It also suggests that participants actually felt connected with their avatar – which is a good thing – as a result tend to link any action of the avatar to their own life. It shows that this player was able to link the game activity to real world junk activities which is a necessary step towards transferring experience from games (in-game learning) to real word behaviour change. This may be a desirable attribute to harness for developing effective persuasive health games. However, it is necessary to apply caution in deciding on the frequency at which players can be destroyed in the game to avoid scaring them from playing the game.

Increase the motivational appeal of rewards by exposing details about them: It is a common practice for game designers to withhold details about the rewards to arouse curiosity and trigger a sense of fun associated with taking chances. According to Wang [191]:

"*Interest in rewards can be increased by withholding details about them. Players who are not completely certain about what needs to be done to gain a reward may exert considerable energy trying to figure that out; many players consider this learning process enjoyable."*

However, the results from the evaluation of JunkFood ALIENS show that reward mechanism that allows players access to specific details of what is required to earn them can increase anticipation that prolongs and enhance the fun associated with the reward. This is supported by comments such as:

- *"I was able to visualize and anticipate the rewards and that made the game really fun and exciting".*

This may be due to a sense of hope created by players' ability to visualize the rewards and what is required to unlock each of them. This helps them to pace themselves accordingly, which is not applicable to games where details of what is required to earn the rewards are withheld. This implies that designers of persuasive games for health should employ reward mechanisms that withheld details of the requirements with caution as it could possibly discourage players especially if the rewards are infrequently earned.

Increase the motivational appeal of persuasive game by allowing players to compete with familiar or similar others: Several persuasive games that employ the competition strategy often involve competing with similar others (for example see [78,183]). This is based on the belief that 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) [62]. However, research has shown that some people are uncomfortable competing with familiar others (e.g., family and friends) because the competition may create some tension in their relationship [78,183]. The results from the evaluation of JunkFood ALIENS show that competition does not necessarily have to be between similar or familiar others for persuasive games for health to be effective. Therefore, competing with unknown others or hypothetical opponents may be a better alternative (to competing with familiar others) especially for people that are uncomfortable competing with familiar others. However, it is important to note that just as suggested by Fogg [62], some of our participants preferred to compete with familiar others. For example, participant C1 in our study requested to be given the opportunity to compete with a friend or to select known people that he can compete with. This is further supported by the excitement shown by a participant who felt that one of the players he competed with was a friend: *"I saw one of my buddy who was also playing. "Name" was pretty good! He gave me a tough time, so I played longer to redeem myself... I was on top of it finally – really had fun."*

6.5 Limitations

The results from the evaluation of JunkFood ALIENS show that the tailored persuasive game was more effective than the random or contra-tailored conditions. However, the study has a number of limitations that are worth acknowledging.

The first is the relatively short time between playing the game and administering the post-test. Since the intervention effect was only measured immediately following the persuasive game play, the findings from this study may not account for the long-term influence or effectiveness of persuasive games.

JunkFood ALIENS was designed to be played multiple times, however, due to the experimental situation, participants played the game only once, therefore, the evaluation can only claim the effectiveness of JunkFood ALIENS for one time – short time – change. Additionally, although, the results from our evaluation showed the efficacy of JunkFood ALIENS at motivating healthy change in attitude, self-efficacy, and intention, which are the three main predictors of behaviour, the efficacy of Junk Food ALIENS to promote actual behavioural change will not be established without further studies.

JunkFood ALIENS is based on eating behaviour, therefore, the results from the studies may not be applicable to other domains (e.g., physical activities). However, because the persuasive strategies and the gamers' preferences for them were not specific to the study domain, I believe that the effect of the study domain on the result (if any) will be very small. Nevertheless, further studies are needed to establish this. Finally, the use of subjective measures presents a limitation to this study. Although self-report is the most common measure of attitude change, the quality of obtained results could be affected by some factors including participants' moods. Therefore, it is necessary to replicate the presented study on another population or on the same population over a period of time.

The result of the evaluation of JunkFood ALIENS shows that the tailored version inspired better play experience – enjoyment and competence – and also more persuasive (promoted more positive changes in attitude, self-efficacy, and healthy eating intention) than the contra-tailored version. Hence, it is possible that the persuasiveness is mediated by game enjoyment and the efficacy is driven by the enjoyment and competence. Therefore, it will be interesting for future work to investigate the relationship between system persuasiveness and perceived system enjoyment and competence to establish any mediating effect. Finally, the present study did not account for the distribution of the participants in the one-size-fits-all condition with respect to their gamer type (apart from the fact that they are neither achievers nor conquerors). Therefore, it is possible that this group is dominated by participants of particular gamer type.

6.6 Summary

The Model-driven Persuasive Game evaluation, which was an attempt to test the validity of the model for tailoring persuasive games to various gamer types described in Chapter 4 shows that while a persuasive game can be effective for changing attitude to, self-efficacy of, and intention towards healthy eating behaviours, the effectiveness depends on using appropriate persuasive strategy for each gamer type. Using the contra-tailored persuasive game – the game designed using the strategy that a particular gamer type would not be receptive to – did not increase either attitude towards healthy eating or self-efficacy and led to a decreased game enjoyment and play experience for that particular gamer type. Conversely, the tailored persuasive game – the game adapted to fit with the receptive strategies for a particular gamer type, led to an increase in attitude, self-efficacy, and healthy eating intention and increased game enjoyment and play experience. Not surprisingly, the random assignment condition had an intermediate effect and was generally less effective than the tailored condition. The result that is consistent for all the behaviour change measures – attitude, self-efficacy, and intention – and the play experience measures, shows that persuasive game interventions are likely to be more effective if they are tailored to the gamer types under consideration. Gamer types have proved to be a useful and effective variable for tailoring persuasive games. In summary, assuming that game players will respond in a similar manner to popular strategies employed in persuasive games (as in the one-size-fits-all approach) is not a good approach for persuasive game designers to take. Rather, my work shows that by employing popular strategies with the wrong type of gamer (as predicted by the model), designers will provoke a negative reaction (that will likely demotivate behaviour change, as shown by the negative mean change in attitude) and therefore, not succeed in their persuasive purpose. On the other hand tailoring the strategies according to the model will most likely create a positive and compelling persuasive experience that will promote positive changes in behaviour. Perhaps the most important use of our model is to avoid using the wrong strategies, which may be counterproductive [103].

CHAPTER 7

DISCUSSION

This dissertation exposed the limitations of the current one-size-fits approach to persuasive game design and proposed the Model-driven Persuasive Game (MPG) design approach for tailoring persuasive games to the seven gamer types identified by the BrainHex model. The MPG was based on two large-scale studies of determinants influencing gamers' (eating) behaviour and the persuasiveness of various persuasive game design strategies. To establish the feasibility of the proposed MPG, I designed and evaluated two versions of a MPG designed to encourage healthy eating attitude in players. The evaluation of the two versions, – presented in the Chapter 6, shows that the tailored persuasive game version is more effective at motivating healthy attitude, self-efficacy, and intention change than the randomly assigned persuasive game and the contra-tailored persuasive game, which was actually shown to demotivate behaviour change (as shown by a negative mean change in attitude). In this chapter, I first present a summary of the findings of this dissertation by highlighting the key benefits of using the MPG as opposed to the design by intuition approach (which assumes the one-size-fits all approach). Finally, I discuss some key issues and implications of the findings in this dissertation for PT designers in general.

7.1 Summary of Findings

The evaluation of the Model-driven approach to persuasive game design highlights some advantages of the MPG. In this section, I highlight the key benefits.

- A tailored persuasive game is more effective than both the contra-tailored and the one-size-fits-all persuasive game for motivating healthy attitude, self-efficacy, and intention.
- A tailored persuasive game inspires better play experience than both the contra-tailored and the one-size-fits-all persuasive game.
- Not considering the gamer type of the participants, it appears as though neither of the game intervention types were more successful (this was shown in the non-significant intervention

type by time interaction) – this is what several designers do when evaluating their system. However, considering gamer type in the 3-way interaction made the benefit of personalization clear.

- Persuasive game designers do not have to combine multiple strategies in a single game to make it effective. Persuasive games designed using a single appropriate strategy (just as in the design of JunkFood ALIENS) could be effective.
- The strategies and determinants vary in their effectiveness depending on the user or user group under consideration.
- The reward strategy that is often employed in persuasive game design is not effective for the bulk of people. This means that persuasive games employing reward may not be effective for promoting desired behaviour change for the majority of players.
- Persuasive game designers do not have to design each game version from scratch to adapt it to the target audience. Tailoring can easily be achieved by incorporating appropriate persuasive strategies into existing games.
- The MPG design approach provides an effective guideline for tailoring persuasive games to the seven gamer types to increase the efficacy of the game (by using appropriate strategies and by manipulating the right determinants).
    - The MPG design approach highlights strategies and determinants that are perceived as positive by each gamer type and therefore, should be reinforced for gamers of this type.
    - The MPG design approach highlights strategies and determinants that are perceived as negative by each gamer type and therefore, should be avoided for gamers of this type.
    - The MPG design approach highlights strategies and determinants that are not significantly associated with each gamer type and may not lead to a significant behaviour change and therefore could be ignored.

7.2 The Implications of the Findings in Advancing the Design of Persuasive Technology

The findings presented above raise some issues which have implications for PT design in general and I discuss them below

7.2.1 The Effectiveness of Using single or Multiple Strategies in PT Design

Because decisions on strategies to employ in PT designs are often based on intuition – guess work – it is a common practice for PT designers to incorporate multiple strategies in a single PT. This is done with the hope that at least one of the strategies will be suitable for motivating behaviour change in the target audience or will appeal to different type of persons who may be present in a one-size-fits-all approach. According to Harjumaa et al. [83], persuasive strategies are often applied in combinations when incorporated as actual software functionalities. The direct result of this is an overly complex persuasive system that may overwhelm the users and lead to cognitive overload. This is supported by the finding by Khaled et al. [110] that having too many features in a persuasive game overwhelmed participants and led to cognitive overload. Another problem of using multiple strategies in a single persuasive system is that it makes it difficult to evaluate what strategy worked (for which audience) and why they work, thereby making it difficult to use results from a successful PT in another PT implementation.

The results from the evaluation of the two JunkFood ALIENS versions, which were designed using single strategies (reward or competition&comparison), show that using a single appropriate strategy in PT design is effective at motivating attitude, self-efficacy, and intention change – which are the direct predictors of behaviour. However, whether or not using multiple strategies in PT design will lead to more effective PTs is still unclear. Research has shown that combining multiple distinct strategies in PT design does not necessarily result in PTs that are more effective than PTs designed using a single strategy [104]. According to the findings by Kaptein [104], combining multiple strategies can lead to an overall reduced persuasive effect, especially when one strategy used is less effective than the other strategy – "*in some situations using multiple strategies can be detrimental as compared to the presentation of a single, correct, strategy*". This is probably because without using the model-driven approach and corresponding persuasive profiles – such as those presented in Chapters 3 and 4 – for selecting appropriate strategies for tailoring PT to the target user group, there is a greater probability of using a combination of appropriate and inappropriate strategies or a combination of inappropriate strategies that could demotivate behaviour change. However, this does not mean that using a combination of appropriate strategies in PT design will result in PTs that are significantly more effective than a PT designed using single appropriate strategy. Kaptein [104] found that even in situations where two or more strategies are equally effective, "*the persuasion does not always add up*". This suggests that combining multiple preferred strategies in PT design do not produce an additive effect with respect to promoting desired behaviour change. As a result, designers should be cautious when using multiple strategies in PTs design to promote a single action [104]. Tailoring PTs using a single appropriate strategy as identified in the persuasive profiles should lead to a simple and effective PT.

7.2.2 Tailoring to Individual Versus Group-based Tailoring

Research on personalized persuasion has advocated for individual level tailoring with the argument that significant differences may exist at the individual level [104]. Undoubtedly, tailoring to individuals maximizes the influence and the effectiveness of PT interventions; however, it may not be achievable in most cases for two main reasons: One, the cost of developing sufficiently rich user models and possible spectrum of adaptations may be beyond the scope of many persuasive game projects. Two, even if individuals differ significantly, there are finite ways in which people can be uniquely classified with respect to the persuasive approach that can be employed to motivate them. Therefore, group-based tailoring is inevitable. 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. This is based on the fact that significant homogeneity exists among people sharing some common characteristic (e.g., personality type [73] and gender [146]) and the same or similar persuasive approach can be employed to target them. The effectiveness of group-based tailoring over the one-size-fits-all approach reinforces the fact that individuals belonging to the same group such as gamer type share greater similarities than differences.

The model-driven approach employed in this dissertation to tailor persuasive games to the gamer type can be generalized and extended to tailor for non-gamers. I demonstrated from my initial works in Chapter 2 that the approach can be employed to tailor PT to non-gamers by developing models for tailoring to gender, cultural, and age groups. Nevertheless, the difference between group level effect and individual-level effect of various strategies and determinants deserve further research.

7.2.3 Tailor Persuasive Technology by Adapting Only the Strategies Employed

The dissertation effectively demonstrated that tailoring can increase the effectiveness of persuasive games at motivating healthy attitude, self-efficacy, and intention to change. One of the drawbacks of tailoring PT intervention is the cost – the level of work involved in designing/adapting PTs for each user type. The success of the two versions of JunkFood ALIENS shows that game designers do not have to design each game version from scratch to adapt it to the target audience. Tailoring can easily be achieved by incorporating appropriate strategies into existing PTs. Designers can easily change the strategies without changing PTs as exemplified in the design of the two versions of JunkFood ALIENS. The success of tailored JunkFood ALIENS shows a great promise and future for using tailored PTs as tools for promoting healthy behaviour. This implies that existing PTs can easily be adapted to suit the target audience by incorporating appropriate persuasive strategies following the persuasive profiles.

7.2.4 Gamification and Design for Engagement

The results from my dissertation also have implications for designing systems that will engage users. Recent years have witnessed an increasing number of non-gaming application that employ game mechanics (such as rewards and leaderboards – depicting competition) in their application to engage the user and get them to continue using their application. This act of using game elements in non-game systems has been referred to as gamification [52]. The results from my dissertation have implications for such systems. For example, offering users rewards for performing desired actions (e.g., points) is one of the most common approaches used in gamified systems to engage users. However, this dissertation has shown that reward is not as effective a motivator as designers thought and may not work for the majority of the people. Therefore, there is a need to tailor gamified systems and the model-driven approach presented in this dissertation could be used for this.

To support my point that gamified systems need to be tailored, in 2011 Gartner [68] predicted that "*by 2015, more than 50 percent of organizations that manage innovation processes will gamify those processes.*" However, after further investigations, in the latest prediction, Gartner [69] stated that by 2014,*"80 percent of current gamified applications will fail to meet business objectives primarily due to poor design."* Using wrong game mechanics for the various user types is a poor design approach, therefore, there is a need to tailor gamified systems and my model-driven approach can be applied.

7.2.5 Using Persuasive Profiles to Design Persuasive Technology

A *persuasive profile* is a collection of various determinants or strategies and the estimation of their effectiveness in influencing behaviour change for various users or a user group [104]. The persuasive profile indicates which strategies should be emphasized in persuasive system design and the ones that should be avoided. Persuasive profiles can be created using various users' characteristics, including demographic information, gender, personality measures or even a combination of these characteristics. I have demonstrated in this dissertation that gender, cultural orientation, age, and gamer type are effective characteristics for constructing persuasive profiles and for tailoring PTs. This profile can guide PT designers in deciding on the appropriate determinants to manipulate or appropriate strategies to employ in PT design.

Researchers have argued that persuasive profiles designed in one domain (e.g., healthy eating) can be used for motivating behaviour change in another domain (e.g., physical activity). According to Kaptein [104] PTs that use persuasive profiles are end-independent, as a result, persuasive profiles created in one domain can be used in bringing about behaviour and/or attitude change in the same domain or in a quite different domain. "*Persuasion profiles are designed and expected to be independent of particular ends and contexts"* and therefore the*"average effect of a strategy for the population and the effect of that strategy for a specific individual is relatively consistent across context and ends* [104]." However, further research is needed to establish the applicability of the persuasive profile across domains.

7.2.6 Ethical Implications of Persuasive Profiles and Persuasive Technology

As research on PTs for behaviour change becomes increasingly important and sophisticated, questions regarding the ethics of such systems cannot be avoided. As a result, attempts have been made toward developing frameworks and principle for the ethical evaluation of persuasive systems [21,62].

Berdichevsky and Neuenschwander [21] proposed a comprehensive framework for evaluating the ethics of any persuasive system. This framework suggests three factors to be considered when designing any persuasive technology: *intents/motivations, methods,* and *outcomes*. They also specify some ethical principles, which should guide the design and development of PTs. The principles are summarized thus:

1. The intended outcome of a persuasive system should not be unethical;
2. The motivation behind the creation of a persuasive system should not be unethical;
3. The creators of persuasive systems must assume responsibility for all predictable outcomes of its use;
4. The creators should respect the privacy of users, at least as much as they respect their own privacy;
5. The creators of a persuasive system should make its motivations, methods, and intended outcomes visible to its users except if such disclosure would significantly undermine an otherwise ethical goal.
6. Persuasive systems should not provide inauthentic information in order to achieve the persuasion goal.
7. The creators of a persuasive system should never try to persuade others of something they would not consent to be persuaded for themselves.

The end-independent nature of persuasive profiles as argued by some researchers [104], if established, may raise some ethical concerns. An ability to use persuasive profiles of an individual developed in one domain in another domain may mean that the profiles can be used for both good and bad purposes. For example, a profile constructed to increase energy conservation can be used to motivate owners to purchase more products and services online. However, inappropriate use of the persuasive profile has been addressed by the Berdichevsky and Neuenschwander [21] framework in principles 4 and 5 – "*The creators should respect the privacy of users, at least as much as they respect their own privacy*" and "*The creators of a persuasive technology should make its motivations, methods, and intended outcomes visible to its users except if such disclosure would significantly undermine an otherwise ethical goal*".

In addition, Kaptein and Eckles [101] argue that failure to tailor PT using persuasive profiles may in itself be unethical. To illustrate this, in one hand, consider a person called Bob, who has an aversion for competition and comparison and walks out only once in a week. On the other hand, consider a PT designer who aims at motivating Bob to increase his physical activity by increasing his daily step counts. The designer uses a persuasive system that tracks Bob's step count using an accelerometer and compares it with that of Bob's friends. The system provides Bob with feedback highlighting the winner in the competition based on the total step count. Because Bob is competition averse and dislikes to be compared with his friends, he stops walking out and exercising entirely, and his total physical activity is reduced. As a result, the system which was intended to promote physical activities has ended up decreasing it, because of the designer's failure to use the persuasive profile to know that Bob is demotivated by competition and comparison. According to Kaptein and Eckles [101], failure to use persuasive profiles can be seen to be unethical in this case. The importance of using persuasive profiles is even more pronounced for persuasive systems targeted at promoting healthy behaviour because the adverse effects may be more critical.

These guidelines seem to cover the crucial ethical aspects, but it is hard for persuasive designers to follow them judiciously. Special attention, however, ought to be given to situations where persuasion takes place unconsciously (without users being aware) [182]. This is because in such situations, there is a higher tendency of violating the principles, especially principles 2, 4, and 5 and the designers may not want to assume responsibility.

CHAPTER 8

CONCLUSION AND FUTURE WORK

Persuasive games can be effective tools for motivating healthy behaviours and/or attitudes, and recent years have witnessed an increasing number of persuasive games. However, many designers treat gamers as a monolithic group by adopting a one-size-fits-all approach in their persuasive games intervention design.

To solve this problem, this dissertation proposes a model-driven approach for tailoring persuasive games to various gamer types called the Model-driven Persuasive Game (MPG) design approach and applied it to two large-scale studies to develop models for tailoring persuasive games to various gamer types as identified by BrainHex. In the first study, I examined gamers' eating behaviours and associated determinants, using the Health Belief Model (HBM), and developed models for tailoring behaviour determinants described in Chapter 3. In the second study, I examined the persuasiveness of ten commonly used persuasive game design strategies and developed models for tailoring the strategies to various gamer types – Chapter 4. Through the models, I identified some variation in the perceptions of various health determinants and the persuasiveness of strategies depending on the player's gamer type. Some determinants and strategies that are positively associated with behaviour change for some gamer types are negatively associated with behaviour change for others.

To demonstrate the feasibility of the MPG design approach, I applied it in designing and developing two versions of a MPG (called JunkFood ALIENS-R and JunkFood ALIENS-C) targeting two distinct gamer types. JunkFood ALIENS-C implemented the Competition/Comparison strategy while JunkFood ALIENS-R implemented the Reward strategy. Both JunkFood ALIENS-C and JunkFood ALIENS-R were made up of the same game features, the only difference between them was the persuasive strategy employed – Chapter 5.

The models (in Chapter 4) describe how conquerors are persuaded by Competition/Comparison, but not by Reward, whereas achievers are persuaded by Reward but not by Competition/Comparison. By including these two groups of gamers and the two versions of JunkFood ALIENS, we were able to test the effects of tailored interventions (JunkFood ALIENS-C for conquerors and JunkFood ALIENS-R for achievers) versus contra-tailored interventions

(JunkFood ALIENS-R for conquerors and JunkFood ALIENS-C for achievers). I also included a general group (all remaining gamer types) to investigate the effects of applying a one-size-fits-all strategy. To demonstrate the importance of tailoring persuasive games for promoting healthy behaviour using the MPG approach, I conducted a large-scale evaluation of the two versions of JunkFood ALIENS with respect to their ability to promote positive changes in attitude, self-efficacy, and intention. To also measure the game play experience, I measured perceived enjoyment and competence from playing the game as described in Chapter 6.

The Model-driven Persuasive Game evaluation shows that while persuasive games can be effective for changing (eating) behaviour – attitude, self-efficacy, and intention – the effectiveness depends on using the right choice of influence strategy for the right gamer type. Playing the contra-tailored persuasive game – game designed using the strategy that a particular gamer type would not be receptive to – did not increase either attitude towards healthy eating or self-efficacy and led to a decreased game enjoyment and play experience for that particular gamer type. Conversely, the tailored persuasive game, adapted to fit with the receptive strategies for a particular gamer type, led to an increase in attitude, self-efficacy, and healthy eating intention and increased game enjoyment and play experience. Not surprisingly, the random assignment condition had an intermediate effect and was generally less effective than the tailored persuasive games. The results, which are consistent for all the behaviour change measures – attitude, self-efficacy, and intention – and the play experience measures, show that persuasive game interventions would be more effective if they are tailored to the gamer types under consideration. Gamer types have proved to be a useful and effective variable for tailoring persuasive games. In summary, assuming that game players will respond in a similar manner to popular strategies employed in persuasive games (as in the one-size-fits-all approach) is not a good approach for persuasive game designers to take. Rather, my work shows that by employing popular strategies with the wrong type of gamer (as predicted by the model), designers will provoke a negative reaction (that will likely demotivate behaviour change, as shown by the negative mean change in attitude) and therefore, not succeed in their persuasive purpose. On the other, hand tailoring the strategies according to the model will most likely create a positive and compelling persuasive experience that will promote positive changes in behaviour. Perhaps the most important use of our model is to avoid using the wrong strategies, which may be counterproductive [103].

8.1 Contributions

Most persuasive games for health use a one-size-fits-all design with the assumption that all people are motivated to change by the same factors. This dissertation detailed the work that I have done to answer my overarching research question: ***how can persuasive games be tailored to increase their efficacy at motivating health behaviour change and is there value in tailoring persuasive games for health?*** The dissertation made five main contributions to the PT for behaviour change literature.

8.1.1 Developed the MPT Design Approach

I developed the MPT design approach for tailoring PTs through two preliminary large-scale studies (N=221, N=554) that investigated and model the determinants of healthy eating for people from different cultures, of different ages, and of both genders.

In the first study, I investigated the determinants influencing fast food eating behaviour and developed models for motivating healthy fast food eating attitude. To adapt the models to various gender groups, I developed two separate models for tailoring PT to males and females. In the second study, I examined the variations in the determinants influencing healthy eating behaviour using the Health Belief Model (HBM) and developed ten different models and persuasive profiles for tailoring PT to various cultural subgroups – Chapter 2. Based on the results of these preliminary studies, I proposed the model-driven approach for tailoring PT called MPT.

8.1.2 Developed Models for Tailoring Health Behaviour Determinants to Various Gamer Types

I developed models for tailoring behavioural determinants to various gamer types – achiever, conqueror, daredevil, mastermind, seeker, socializer, and survivor – identified by BrainHex based on a large-scale study of 642 participants. The persuasive profiles from these models serve as guidelines for selecting appropriate determinants to manipulate in PT interventions – Section 3.5.

To make the findings actionable for designers of persuasive games, I mapped the determinants of health behaviour to common game mechanics that can be employed in persuasive game design. Having a personalized persuasive profile of what motivates different gamer types, and mapping these behaviour determinants to game mechanics, provides a crucial theoretical and methodological bridge between research on what motivates health behaviour change (i.e., theories) and research on designing games for health (i.e., persuasive games). The model-driven and gamer type-relevant design approaches are immediately actionable for designers to build effective persuasive games for motivating health behaviour change (Section 3.5).

8.1.3 Developed Models for Tailoring Persuasive Strategies to Various Gamer Types

I conducted a cross validation of the persuasiveness of ten commonly employed PT strategies and developed models showing the receptiveness of the seven gamer types to the PT strategies based on a large-scale study 1108 participants. I proposed a model-driven design approach for tailoring persuasive games for health that is based on developing persuasive profiles (comprising a list of suitable PT strategies) for each gamer type identified by BrainHex. Based on the results from the models, I highlighted the best overall strategies that were perceived as positive by most gamer types and the least efficacious strategies that were not perceived as persuasive by most gamer types. Finally, to bridge the gap between PT designers and designers of games, I proposed a mapping of PT strategies to appropriate game design mechanics – Section 4.5.

On a more specific not, the models show that one of the popular strategies (rewards) that are often employed in persuasive games design is not effective for the bulk of people. This means that persuasive games employing reward may not be effective for promoting desired behaviour change for the majority of players.

Having persuasion profiles of various persuasive strategies that motivate different gamer types provides a crucial methodological bridge between game researchers and Persuasive Technology (PT) researchers and also between personalization researchers and PT researchers. The proposed model-driven approach for tailoring persuasive games benefits from the best practices of both game design and PT researchers – Section 4.5.

8.1.4 Developed a Model-driven Persuasive Game

I developed two versions of a model-driven persuasive game intervention called JunkFood ALIENS-C and JunkFood ALIENS-R. JunkFood ALIENS was developed as a proof of concept persuasive game to show the feasibility of the MPG intervention that were informed by my models for tailoring persuasive games to gamer types – Chapter 4. JunkFood ALIENS was designed to motivate healthy behaviour by promoting healthy eating attitude, self-efficacy, and intention. JunkFood ALIENS-C was tailored to conquerors, while Junk Food ALIENS-R was tailored to achievers – Chapter 5.

Although the content, design, and implementation of the two versions of JunkFood ALIENS differ in the persuasive strategy employed, they both have identical game mechanics. Thus, the play experience of the game is the same – only the persuasive intervention changes. Through the design of JunkFood ALIENS, I show that persuasive games designers do not have to design each game version from scratch to adapt it to the target audience. Tailoring can easily be achieved by incorporating appropriate PT strategies into existing games.

8.1.5 Conducted a Large-scale Evaluation of the Model-Drive Persuasive Game

To determine and compare the efficacy of tailored, contra-tailored, and randomly assigned JunkFood ALIENS at promoting healthy (eating) attitude, self-efficacy, and intention, I conducted a large-scale quantitative study and a follow-up study to gain deeper insights into the dynamics of the in-game behaviours of different game types. The model-driven persuasive game evaluation, which was intended to test the validity of my models for tailoring persuasive games to various game types, showed that while persuasive games can be effective for changing (eating) behaviour – attitude, self-efficacy, and intention – the effectiveness depends on using the right choice of influence strategy for the right gamer type. The results from the evaluation were consistent for all the behaviour change measures – attitude, self-efficacy, and intention – and the play experience measure. They answered the research question – *whether there is a value in tailoring persuasive games?* – by showing that persuasive game interventions are more effective if they are tailored to the gamer types under consideration. Not tailoring persuasive games could be detrimental because the contra-tailored persuasive game condition showed a decrease in healthy eating attitude in favour of unhealthy eating. Gamer types have proved to be a useful and effective variable for tailoring persuasive games – Chapter 6.

Again, through evaluations of the two versions of Junk Food ALIENS, I showed that persuasive game designers do not have to combine multiple strategies in a single game to make it effective. Persuasive games designed using a single appropriate strategy (just as in the design of JunkFood

ALIENS) could be effective. The two preliminary studies show that MPT design approach can be applied in tailoring PTs to non-gamers using other differentiable user characteristics such as gender and age.

8.2 Future Work

The work in this dissertation represents a first step towards tailoring persuasive games to gamer types and validating the effectiveness of various PT design strategies and behaviour determinants for various game types. Although this study showed many interesting and significant findings, it also opens up many opportunities for further research.

In the future, I will pursue a number of extensions to the model-driven approach to persuasive game design discussed in this dissertation. Here, I discuss a few ways that the research could be extended (in addition to the future work already contained in the individual chapters).

8.2.1 Exploring the Relationship Between Play Experience and Persuasiveness

The result of the evaluation of JunkFood ALIENS shows that the tailored version inspired better play experience (enjoyment and competence) and was also more persuasive (promoted more positive changes in attitude, self-efficacy, and healthy eating intention) than the contra-tailored version. Hence, it is possible that the game's persuasiveness is mediated by game enjoyment and the efficacy is driven by the enjoyment and competence. Therefore, it will be interesting for future work to investigate the relationship between system persuasiveness and perceived system enjoyment and competence to establish any mediating effect.

8.2.2 Large-scale and Longitudinal Evaluation of Junkfood ALIENS

Conducting a large-scale longitudinal evaluation of JunkFood ALIENS would make it possible to investigate the mediating effect of gender, age, and cultural orientation on the influence of the strategies and how these factors interact with gamer type to affect the efficacy of persuasive games.

To elicit further information relating to game experience, the game could be designed to track and log players' in-game activities. The activity log would provide information regarding the strategies and the activity that the players spent more time using.

It would also be possible to examine the longitudinal effects of the JunkFood ALIENS on the players' behaviours. This could be achieved by allowing players to play the game for an extended period of time (e.g., one week) after they have completed the baseline survey. Players could complete the post survey immediately following the game play period and several days (e.g., one week) after game play to determine if the change would persist over a period of time.

It is also important to move beyond changes in attitudes and intentions, to investigate how we can help people change their behaviour. Although attitude, intention, and self-efficacy are the foundations on which behaviour change is built, we need to demonstrate changes in actual behaviour to ultimately show that games can improve the health of players. In future work, I plan to perform a large-scale controlled study to investigate for the direct effect of playing JunkFood ALIENS on players' health behaviour.

8.2.3 Developing Comprehensive Model for Tailoring Persuasive Games

The results from the studies in this dissertation show that significant variabilities exit between the gamer types with respect to the determinants of their behaviour and the persuasiveness of the strategies. With a very large-scale study, it should be possible to investigate for possible moderating effect of other known differentiating user characteristics such as gender, age, and culture. It is possible that these variables significantly interact with the players' perception of a strategy and its influence on their behaviour. As a result, finer-grain tailoring to various sub-groups within each gamer type (e.g., female achievers, collectivist conquerors) would further improve the efficacy of persuasive health games.

I considered only ten commonly used strategies in this dissertation. Future research could expand on this and validate the effectiveness of more strategies and develop comprehensive models for tailoring the strategies to the gamer types.

8.2.4 Developing a Different Persuasive Technology Using Model-Driven Approach

The feasibility and the efficacy of my proposed model-driven approach have been effectively demonstrated in the design and evaluation of JunkFood ALIENS. I have also shown that my proposed model-driven approach could be applied to tailor PT to non-gamers by considering other characteristics, such as gender, age, and cultural background – Chapter 2. An interesting future extension would be to develop and evaluate a completely different kind of persuasive system (that is not necessary game based) using the model-driven approach and tailoring its intervention using other user characteristics (e.g., gender and age) – as presented in the models in Chapter 2. It would be also interesting to investigate the persuasiveness of the strategies for non-gamers and create models for tailoring PT in general to non-gamers using other users' characteristics. This would further establish the generalizability and the efficacy of my proposed model-driven approach for tailoring PT in general.

8.2.5 Explore the Generalizability of MPG by Applying the Models in a Different Domain

The models developed in Chapter 4 was used in developing JunkFood ALIENS in Chapter 5 and was found effective at motivating healthy behaviour change in Chapter 6. An interesting extension would be to develop and evaluate another persuasive health game using the same MPG approach and the same strategies used in JunkFood ALIENS, but focusing on different health-related issues (e.g., promoting physical activity, smoking or alcohol cessation). Evaluating the game using similar methods used in JunkFood ALIENS in Chapter 6 – baseline and post-surveys and a follow-up study – would make it possible to establish the domain-independent and the wider generalizability of my models for tailoring persuasive health games. It would also enable me to establish if there are particular tasks or behaviours that individual strategies are naturally more inclined to promote.

8.2.6 Design a Persuasive Game Using Multiple Strategies

There have been some speculations that combining multiple strategies can lead to an overall reduced persuasive effect [104], however, the authenticity of these have not been fully established – especially for persuasive games. JunkFood ALIENS presents a convenient platform for combining and evaluating the efficacy of persuasive games designed using a mix of strategies (a combination of preferred and not preferred, two or more preferred strategies, two or more not preferred strategies). Evaluating the game using the same approach employed in the evaluation of JunkFood ALIENS in Chapter 6 would help establish if persuasive games designed using a single strategy are more effective than those designed using a combination of strategies.

8.2.7 Objectively Studying Individual Strategy Preference

It could be possible to use players' in-game behaviours to determine their strategy preferences. Persuasive games could be designed to allow players the flexibility of adapting the strategies in the game by either enabling or disabling any strategy as players may deem necessary. Tracking, logging, and analyzing players' activities in a large-scale study would allow one to investigate and possibly develop models for tailoring persuasive games using players' in-game behaviours.

The findings from this dissertation opens up more room for future research on designing effective PT for promoting healthy behaviour.

8.3 Summary

In summary, this dissertation contributes in advancing the field of persuasive technology and design of interactive applications for promoting behaviour change in general by effectively answering an important question of *whether there is any value tailoring Persuasive Technologies (PTs)*? The dissertation not only demonstrated that *one size does not fit all* (through extensive large-scale studies and modeling), it also effectively demonstrated that tailoring PTs can increase their effectiveness at motivating behaviour change (through implementation and large-scale field studies of the efficacy of a tailored, contra-tailored, and one-size-fits-all versions of a PT called JunkFood ALIENS). The tailored versions of JunkFood ALIENS were more effective than both the contra-tailored and the one-size-fits-all versions of JunkFood ALIENS. More importantly, the eveluations of JunkFood ALIENS revealed that without considering the type of person using the system (gamer type in this case), it appeared as though there is no difference between various persuasive approaches (this was shown in the non-significant intervention type by time interaction). This is wrong as the persuasive strategies vary in their effectiveness depending on the gamer type of the person using the system. Nevertheless, the vast majority of persuasive systems designers do exactly this (do not consider the individual) when evaluating the effectiveness of their systems and it explains why there are so many inconsistent results from the evaluations of various persuasive systems. However, when I considered the type of person using the system (the 3-way interaction), the benefits of personalizing persuasive systems become crystal clear. I clearly show that different people respond differently to various strategies, but also that a relevant and good typology for describing people (such as BrainHex in my case, or FFM or culture or gender) allows for effective group-based tailoring. This compromise (group-based tailoring rather than tailoring to individual) moves designers from designing ineffective interventions to effective ones. The future work will investigate how clarifying this typology (e.g., by considering also culture, gender, age) may or may not further improve the efficacy of persuasive interventions.

The dissertation successfully demonstrates that there is value in tailoring persuasive technology, thereby stressing the need for designers to tailor PTs to increase their effectiveness. However, tailoring has always been thought of as very tedious work. One of the drawbacks of tailoring persuasive game interventions is the cost – the level of work involved in designing/adapting persuasive games for each gamer type. The results from the design and evaluation of the two versions of JunkFood ALIENS shows that game designers do not have to design each game version from scratch to adapt it to the target audience. Game designers can change the strategy to adapt to the target audience without changing the game. Specifically, I demonstrated that tailoring can easily be achieved by incorporating appropriate strategies into existing games. The success of this approach to tailoring shows great promise for using tailored persuasive games as a tool for promoting healthy behaviour. It implies that existing persuasive games and PTs in general can easily be adapted to suit the target audience by incorporating appropriate persuasive strategies following the persuasive profiles.

Another important contribution of this dissertation that has enormous implications for PT design is the possibility of motivating behaviour change using a single strategy. This dissertation shows that it is possible to motivate desired behaviour change using a single strategy implementation in PT. This is important because employing multiple strategies in PT design (which often leads to overly complex PT that may overwhelm the users and lead to cognitive overload) is a standard practice within community of PT for behaviour change. Before my work, it was unclear whether or not it is possible to use only a single strategy to motivate behaviour change. The design and evaluation of the two versions of JunkFood ALIENS (each using a single strategy) establish that it is possible to promote behaviour change using a single appropriate strategy – as decided by a user's persuasive profile – thereby establishing a future design approach and direction for PT for behaviour change designers.

Also equally important but probably contrary to popular expectations, is the fact that one of the popular strategies (reward) that is often employed in persuasive games design is not effective for the bulk of people. This means that persuasive games employing reward may not be effective for promoting desired behaviour change for the majority of players. This is particularly interesting because employing reward in PTs design has been a controversial topic and many PT designers believe that reward is important for motivation. The finding from this dissertation reveals that reward may not be as important a motivator as designers previously thought. Therefore, designers should employ reward with caution. The surprising effect of reward points to the need to validate other strategies with respect to their persuasiveness.

These findings contribute in advancing the field of persuasive technology and the design of interactive applications for promoting behaviour change in general by showing the values of tailoring PTs, the need to tailor PTs (by highlighting the danger of taking the one size-fits-all approach), and demonstrating much easier ways that PTs can be tailored to reduce cost, labor, and still increase their efficacy. In general, the dissertation highlighted some subtle and important design considerations for designing effective persuasive technological interventions.

My Peer-Reviewed Publications With Contents From This Dissertation

The work reported in Chapter 2 through Chapter 4 have been published and below are publications resulting from the Chapters.

Journal Papers

1. **Orji, R.**, Vassileva, J., Mandryk, R. L, (Accepted). Modeling the Efficacy of Persuasive Strategies for Different Gamer Types in Serious Games for Health. *User Modeling and User-Adapted Interaction (UMUAI) Journal. Special Issue On Personalization And Behaviour Change* – **45 pages.**

2. **Orji, R.**, & Mandryk R. L., (2014). Developing Culturally Relevant Design Guidelines for Encouraging Healthy Eating Behaviour. *International Journal of Human-Computer Studies; Special Issue on Human-food Interaction. 72*(2), pp. 207-223 – **17 pages.**

3. **Orji, R.**, Vassileva, J., & Mandryk, R. L. (2012). Towards an Effective Health Intervention Design: An Extension of the Health Belief Model. *Journal of Public Health Informatics,* 4(3) – **31 pages.**

4. **Orji, R.**, Vassileva, J., & Mandryk, R. L. (2012). LunchTime: a slow-casual game for long-term dietary behaviour change. *Journal of Personal and Ubiquitous Computing*; S*pecial Issue On Persuasion, Influence, Nudge, And Coercion*. *17*(6), 1211-1221 – **10 pages.**

Full Conference Papers

1. **Orji**, R. (2014). Exploring the Persuasiveness of Behaviour Change Support Strategies and Possible Gender Differences. To appear in the *Workshop for Behaviour Change Support Systems, Adjunct Proceedings of Persuasive Technology, Persuasive, Motivating, and Empowering Videogames*, Padova, Italy, May 21-23, 2014 – **17 pages.**

2. **Orji, R.**, Mandryk, R. L., Vassileva, J., & Gerling K. M. (2013). Tailoring Persuasive Health Games by Gamer Type. *Proceedings of ACM CHI Human Factors in Computing Systems – CHI 2013.* Paris, France, ACM pp. 246-2476 – **10 pages.**

3. **Orji, R.**, Vassileva, J., Mandryk, R. L, 2013. Modeling Gender Differences in Healthy Eating Determinants for Persuasive Intervention Design. *Proceedings of Persuasive Technology.* Sydney, Australia, Springer Verlag, pp. 161-173 – **12 pages.**

4. **Orji, R.**, Mandryk, R., & Vassileva, J. (2012). Towards a data-driven approach to intervention design: a predictive path model of healthy eating determinants. *Proceedings of Persuasive Technology, Design for Health and Safety*, Linkoping, Sweden, June 6-8, 2012, Springer Verlag, pp. 203-214 – **12 pages.**

5. **Orji, R.**, Vassileva, J., & Mandryk, R. L. (2011). LunchTime: a slow-casual game for long-term dietary behaviour change. *Proceedings of Persuasive Technology, Enhancing Sustainability and Health.* Unarchived Paper Presented at Persuasive Conference 2012, Ohio, Columbus, USA, June 2-5, 2011 – **12 pages.**

Short Conference Papers

1. **Orji, R.,** (2014). Gender and Persuasive Technology: Examining the Persuasiveness of Persuasive Strategies by Gender Groups. *Adjunct Proceedings of Persuasive Technology, Persuasive, Motivating, and Empowering Videogames, Padova, Italy, May 21-23, 2014* – **5 pages.**
2. **Orji, R.,** Mandryk, R. L. & Vassileva, J. (2014). Selecting Effective Strategies for Tailoring Persuasive Health Games to Gamer Types. RNote, to be Presented at GRAND 2014: *Graphic, Animation, and New Media,* May 13 -16, 2014, Ottawa, Canada – **4 pages.**

3. **Orji, R.,** (2014). Model-driven Persuasive Health Game Design. Doctoral Consortium: *ACM Richard Tapia Celebration of Diversity in Computing* February 5-8, 2014, Seattle, WA, USA – **4 pages.**

4. **Orji R.,** (2013). Does One Size Fit All? Personalizing Persuasive Games for Health by Gamer Types. *Adjunct Proceedings of Persuasive Technology 2013*. Doctoral consortium, Australia, April 3-5, 2013, pp. 1-5 – **5 pages.**

5. **Orji, R.,** Vassileva, J., & Mandryk, R. L. (2012). Providing for Impression Management in Persuasive Designs. *Adjunct Proceedings of Persuasive Technology.* Linkoping, Sweden, Extended Abstracts, pp. 41-44 – **4 pages.**

REFERENCES

[1] AbuSabha, R. and Achterberg, C. Review of self-efficacy and locus of control for nutrition- and health-related behaviour. *Journal of the American Dietetic Association 97*, 10 (1997), 1122–32.

[2] Airhihenbuwa, C. Culture Matters in Global Health. *European Health Psychologist 12*, December (2010), 52–55.

[3] Ajzen, I. and Fishbein, M. The influence of attitudes on behaviour. In & M.P.Z. In D. Albarracín, B. T. Johnson, ed., *The Handbook of Attitudes*. 2005, 173–221.

[4] Ajzen, I. The theory of planned behaviour. *Organizational Behaviour and Human Decision Processes* 50, 2 (1991), 179–211.

[5] Ajzen, I. Constructing a TpB Questionnaire: Conceptual and Methodological Considerations. *Working Paper, University of Massachusetts, Amherst.* (2006). Accessed Dec., 2013 http://people.umass.edu/aizen/pdf/tpb.measurement.pdf

[6] Alexander, J.M. Dieting strategies of college students: a study of behaviours, attitudes and goals, and the influence of restraint and gender. *A Thesis Submitted to the Rutgers University*, (1992).

[7] Anderson, J.C. and Gerbing, G.W. Structural Equation Modeling in Practice: A Review and Recommended Two-Step Approach. *Psychological Bulletin* 103, 3 (1988), 411–423.

[8] Andrew, A., Borriello, G., and Fogarty, J. Toward a systematic understanding of suggestion tactics in persuasive technologies. *Proceedings of the International Conference on Persuasive Technology*, Springer-Verlag (2007), 259–270.

[9] Aristotle. Rhetoric. *The Internet Classics Archive.* (350 B.C.E) Accessed Dec., 2014 http://classics.mit.edu//Aristotle/rhetoric.html

[10] Arteaga, S.M., González, V.M., Kurniawan, S., and Benavides, R. a. Mobile games and design requirements to increase teenagers' physical activity. *Pervasive and Mobile Computing 8*, 6 (2012), 900–908.

[11] Arteaga, S.M., Kudeki, M., and Woodworth, A. Combating obesity trends in teenagers through persuasive mobile technology. *ACM SIGACCESS Accessibility and Computing*, 94 (2009), 17–25.

[12] Entertainment Software Association. Essential facts about the computer and video game industry. (2008) Accessed on Sept., 2010 http://www.theesa.com/facts/pdfs/esa_ef_2008.pdf

[13] Bandura, A. Self-efficacy: Toward a unifying theory of behavioural change. *Psychological Review 84*, 2 (1977), 191–215.

[14] Bang, M., Torstensson, C., and Katzeff, C. The PowerHhouse: A Persuasive Computer Game Designed to Raise Awareness of Domestic Energy Consumption. *Proceedings of the International Conference on Persuasive Technology*, (2006), 123–132.

[15] Baron, R.M. and Kenny, D.A. The moderator–mediator variable distinction in social psychological research: Conceptual, strategic, and statistical considerations. *Journal of Personality and Social Psychology 51*, 6 (1986), 1173–1182.

[16] Bartle, Richard, A. Hearts, Clubs, Diamonds, Spades: Players Who Suit Muds. *Journal of MUD Research 1*, 1 (1996).

[17] Bateman, C. and Boon, R. *21st Century Game Design (Charles River Media Game Development)*. Cengage Learning, 2005.

[18] Bateman, C., Lowenhaupt, R., and Nacke, L. Player typology in theory and practice. *Proceedings of DiGRA 2011 Conference: Think Design Play.*, (2011).

[19] Bateman, C. and Nacke, L.E. The neurobiology of play. *Proceedings of the International Conference on Future of Game Design and Technology*, (2010), 1–8.

[20] Bell, M., Chalmers, M., Barkhuus, L., et al. Interweaving mobile games with everyday life. *Proceedings of the {SIGCHI} Conference on Human Factors in Computing Systems*, ACM (2006), 417–426.

[21] Berdichevsky, D. and Neuenschwander, E. Toward an ethics of persuasive technology. *Communications of the ACM, 42*, 5 (1999), 51–58.

[22] Bergmans, A. and Shahid, S. Reducing Speeding Behaviour in Young Drivers Using a Persuasive Mobile Application. *Human-Computer Interaction. Applications and Services*, (2013), 541–550.

[23] Berkovsky, S., Coombe, M., Freyne, J., Bhandari, D., and Baghaei, N. Physical activity motivating games: virtual rewards for real activity. *Proceedings of the International Conference on Human Factors in Computing Systems*, ACM (2010), 243–252.

[24] Berkovsky, S., Freyne, J., Coombe, M., and Bhandari, D. Recommender algorithms in activity motivating games. *Proceedings of the fourth ACM conference on Recommender systems - RecSys '10*, ACM Press (2010), 175.

[25] Berkovsky, S., Freyne, J., and Oinas-kukkonen, H. Influencing Individually. *ACM Transactions on Interactive Intelligent Systems 2*, 2 (2012), 1–8.

[26] Bjork, S. and Holopainen, J. Game Design Patterns. In A. Salen and E. Zimmerman, eds., *The Game Design Reader: A Rules of Play Anthology*. MIT Press, 2005.

[27] Bogost, I. Persuasive Games on Mobile Devices. *Fogg,BJ; Eckles, Dean.(edts). Mobile Persuasion*, (2007).

[28] De Bourdeaudhuij, I. and Brug, J. Tailoring dietary feedback to reduce fat intake: an intervention at the family level. *Health Education Research 15*, 4 (2000), 449–62.

[29] Brown, B., Chetty, M., Grimes, A., and Harmon, E. Reflecting on health: a system for students to monitor diet and exercise. *CHI'06 Extended Abstracts on Human Fctors in Computing Systems*, ACM (2006), 1807–1812.

[30] Brown, J.N. Choosing the Right Type of Rotation in PCA and EFA. *Shiken: JALT Testing & Evaluation SIG Newsletter. 13*, 3 (2009), 20–25.

[31] Brownson, R.C. and Kumanyika, S. Obesity Prevention: Charting a Course to a Healthier Future. *Handbook of Obesity Prevention*. Springer US (2007), 515–528.

[32] Buhrmester, M., Kwang, T., and D, G.S. Amazon's Mechanical Turk A New Source of Inexpensive, Yet High-Quality, Data? *Perspectives on Psychological Science 6*, 1 (2011), 3–5.

[33] Busch, M., Schrammel, J., FLU, M., Kruijff, E., and Tscheligi, M. Persuasive Strategies *Report. CURE – Center for Usability Research & Engineering*, 2012. Accessed Dec., 2013. http://www.projectpeacox.eu/uploads/media/peacox/public_deliverables/Peacox_D5.1_Persuasive_Strategies_Report.pdf

[34] Cameron, J. and Pierce, W.D. Reinforcement, Reward, and Intrinsic Motivation: A Meta-Analysis. *Review of Educational Research 64*, 3 (1994), 363.

[35] Campbell, M.K., DeVellis, B.M., Strecher, V.J., Ammerman, A.S., DeVellis, R.F., and Sandler, R.S. Improving dietary behaviour: the effectiveness of tailored messages in primary care settings. *American Journal of Public Health 84*, 5 (1994), 783–7.

[36] Carrillo, E., Varela, P., Salvador, A., And Fiszman, S. Main Factors Underlying Consumers' Food Choice: A First Step For The Understanding Of Attitudes Toward "Healthy Eating."*Journal of Sensory Studies 26*, 2 (2011), 85–95.

[37] Chen, L.S.-L. Subjective well-being: evidence from the different personality traits of online game teenager players. *Cyberpsychology & behaviour 11*, 5 (2008), 579–81.

[38] Chin, W.W. The Partial Least Squares Approach to Structural Equation Modeling. *Modern Methods for Business Research*, 1998, 295–336.

[39] Chin, W.W. Frequently Asked Questions – Partial Least Squares & PLS-Graph. 2000. Accessed October, 2013. http://disc-nt.cba.uh.edu/chin/plsfaq.htm.

[40] Cialdini, R.B. The Science of Persuasion. *Scienctific American Mind 284*, (2004), 76–84.

[41] Colineau, N. and Paris, C. Can Beneficial Habits Be Induced through Reflection? *Workshop on User Models and Motivational Systems: The Effective And The Rational Routes To Persuasion, With UMAP'2010.*, .

[42] Conner, M. and Norman, P. Predicting health behaviour: Research and practice with social cognition models. In *Philadelphia: The Open University*. Philadelphia: The Open University, 2005.

[43] Consolvo, S., Everitt, K., Smith, I., and Landay, J. a. Design requirements for technologies that encourage physical activity. *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems - CHI '06*, ACM Press (2006), 457 – 466.

[44] Consolvo, S., McDonald, D.W., and Landay, J.A. Theory-driven design strategies for technologies that support behaviour change in everyday life. *Proceedings Of The International Conference On Human Factors In Computing Systems*, ACM (2009), 405–414.

[45] Cosley, D., Lam, S.K., Albert, I., Konstan, J.A., and Riedl, J. Is seeing believing?: how recommender system interfaces affect users' opinions. *Proceedings of the Conference On Human Factors In Computing Systems - CHI '03*, ACM Press (2003), 585.

[46] Costello, A., Osborne, J., Anna, B., and Jason, W. Best practices in exploratory factor analysis: four recommendations for getting the most from your analysis. 2005. *Practical Assessment, Research & Evaluation 10*, p1 (2011).

[47] Crowther, R., Lennon, J., Blue, A., and Wanish, G. *HTML5 in Action*. Manning Publications, 2014.

[48] Cugelman, B., Thelwall, M., and Dawes, P. The Dimensions of Web Site Credibility and Their Relation to Active Trust and Behavioural Impact. *Communications of the Association for information systems*, 24, 1, 2009.

[49] Cullen, K.W., Watson, K., Baranowski, T., Baranowski, J.H., and ZakeriI, I. Squire's quest: intervention changes occurred at lunch and snack meals. *Appetite 45*, 2, 148–151.

[50] Daniels, A.C. Bringing Out the Best in People: How to Apply the Astonishing Power of Positive Reinforcement. *America Media International*, 2003.

[51] Deshpande, S., Basil, M.D., and Basil, D.Z. Factors influencing healthy eating habits among college students: an application of the health belief model. *Health Marketing Quarterly 26*, 2 (2009), 145–64.

[52] Deterding, S., Sicart, M., Nacke, L., O'Hara, K., and Dixon, D. Gamification. using game-design elements in non-gaming contexts. *Proceedings of the 2011 Annual Conference on Human Factors in Computing Systems - CHI EA '11*, ACM Press (2011), 2425.

[53] Dijkstra, A. Technology Adds New Principles to Persuasive Psychology: Evidence from Health Education. *Proceedings of the International Conference on Persuasive Technology*, (2006), 16 – 26.

[54] Dixon, D. Player Types and Gamification. *CHI 2011 Workshop on Gamification: Using Gane Design Elements in Non-Game Contexts*, (2011), 12–15.

[55] Drozd, F., Lehto, T., and Oinas-Kukkonen, H. Exploring perceived persuasiveness of a behaviour change support system: a structural model. *Proceedings of the International Conference on Persuasive Technology.*, (2012), 157–168.

[56] Drozd, F. Behaviour Change & Technology. 2011. Accessed Dec. 2012 http://www.behaviourchangeandtechnology.org/increasing-exposure-to-internet-delivered-interventions/

[57] Echchakoui, S. Personality Traits and Performance: The Mediating Role of Adaptive Behaviour in Call Centers. *American Journal of Industrial and Business Management 3*, (2013), 17–27.

[58] Entertainment Software Association (ESA). *Essential Facts About the Computer and Video Game Industry*. 2012. Accessed April, 2013. http://www.theesa.com/facts/pdfs/esa_ef_2012.pdf

[59] Entertainment Software Association (ESA). *Essential Facts About the Computer and Video Game Industry*. 2013. Accessed March, 2014. http://www.theesa.com/facts/pdfs/esa_ef_2013.pdf

[60] Fjneman, Y.A., Willemsen, M.E., Poortinga, Y.H., et al. Individualism-Collectivism: An Empirical Study of a Conceptual Issue. *Journal of Cross-Cultural Psychology 27*, 4 (1996), 381–402.

[61] Fogg, B. Persuasive Technologies. *Communications of the ACM 42*, 5 (1999), 26–29.

[62] Fogg, B.J. *Persuasive Technology: Using Computers to Change What We Think and Do*. Morgan Kaufmann, 2003.

[63] Fogg, B.J. Creating Persuasive Technologies: An {Eight-Step} Design Process. *Proceedings of the International Conference on Persuasive Technology*, *ACM*, (2009), 44.

[64] Fornell, C. and Larcker, D.F. Evaluating Structural Equation Models with Unobservable Variables and Measurement Error. *Journal of Marketing Research 18*, 1 (1981).

[65] Freeland-Graves, J. Position of The American Dietetic Association Total Diet Approach to Communicating Food And Nutrition Information. *Journal of the American Dietetic Association 102*, 1 (2002), 100–108.

[66] Froehlich, J., Dillahunt, T., and Klasnja, P. UbiGreen: investigating a mobile tool for tracking and supporting green transportation habits. *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems*, (2009), 1043–1052.

[67] Fujiki, Y., Kazakos, K., Puri, C., Buddharaju, P., Pavlidis, I., and Levine, J. {NEAT-o-Games:} blending physical activity and fun in the daily routine. *Computers in Entertainment 6*, 2 (2008), 1–22.

[68] Gartner. More Than 50 Percent of Organizations That Manage Innovation Processes Will Gamify Those Processes. 2011. Accessed March, 2013. http://www.gartner.com/newsroom/id/1629214.

[69] Gartner. 80 Percent of Current Gamified Applications Will Fail to Meet Business Objectives Primarily Due to Poor Design. (2012). Accessed March, 2014. http://www.gartner.com/newsroom/id/2251015

[70] Gerber, B.S., Stolley, M.R., Thompson, A.L., Sharp, L.K., and Fitzgibbon, M.L. Mobile phone text messaging to promote healthy behaviours and weight loss maintenance: a feasibility study. *Health Informatics Journal 15*, 1 (2009), 17–25.

[71] Glanz, K., Rimer, B.K., and (US), N.C.I. Theory at a glance: A guide for health promotion practice. *U.S. Department Of Health And Human Services*, (1995).

[72] Gneezy, U. and Rustichini, A. Pay Enough or Don't Pay at All. *Quarterly Journal of Economics 115*, 3 (2000), 791–810.

[73] Goldberg, L.R. The structure of phenotypic personality traits. *American Psychologist 48*, 1 (1993), 26–34.

[74] Government of Canada, H.C. Promotion and Support of Healthy Eating: An Initial Overview of Knowledge Gaps and Research Needs, Summary Report, March 2001 [Health Canada, 2003]. 2003. Accessed December, 2011. http://www.hc-sc.gc.ca/fn-an/res-rech/res-prog/eat-aliment/pro_sup_healthy_eating-pro_mes_saine_alimentation-eng.php.

[75] Government of Canada, H.C.H.P. and F.B. How Many Food Guide Servings of Fruits and Vegetables do I Need? - Canada's Food Guide. 2007. Accessed December, 2011.

http://www.hc-sc.gc.ca/fn-an/food-guide-aliment/choose-choix/fruit/need-besoin-eng.php.

[76] Grimes, A., Bednar, M., Bolter, J.D., and Grinter, R.E. EatWell: Sharing Nutrition-Related Memories in a Low-Income Community. *Computer Supported Cooperative {Work-Proceedings} of the 2008 {ACM} conference on Computer supported cooperative work*, (2008), 87–96.

[77] Grimes, A., Kantroo, V., and Grinter, R.E. Let's play!: mobile health games for adults. *Proceedings of the 12th {ACM} International Conference on Ubiquitous Computing*, ACM (2010), 241–250.

[78] Grimes, A., Tan, D., and Morris, D. Toward technologies that support family reflections on health. *Proceedings of the {ACM} 2009 International Conference On Supporting Group Work*, ACM (2009), 311–320.

[79] Guerini, M., Stock, O., and Zancanaro, M. a Taxonomy of Strategies for Multimodal Persuasive Message Generation. *Applied Artificial Intelligence 21*, 2 (2007), 99–136.

[80] Hair, J.F.., Ringle, C.M.., and Sarstedt, M. PLS-SEM: Indeed a Silver Bullet. *Journal of Marketing Theory and Practice 19*, 2 (2011), 139–152.

[81] Halko, S. and Kientz, J. Personality and Persuasive Technology: An Exploratory Study on Health-Promoting Mobile Applications. *Proceedings of the International Conference on Persuasive Technology*, (2010), 150–161.

[82] Hardeman, W., Sutton, S., Griffin, S., et al. A causal modelling approach to the development of theory-based behaviour change programmes for trial evaluation. *Health education research 20*, 6 (2005), 676–87.

[83] Harjumaa, M. Understanding persuasive software functionality in practice: a field trial of polar FT60. *Proceedings Of the International Conference on Persuasive Technology*, (2009).

[84] He, H.A., Greenberg, S., and Huang, E.M. One Size Does Not Fit All : Applying the Transtheoretical Model to Energy Feedback Technology Design. *Discovery*, (2010), 927–936.

[85] Heer, J. and Bostock, M. Crowdsourcing graphical perception. *Proceedings of the 28th International Conference on Human factors in computing systems - CHI '10*, ACM Press (2010), 203–212.

[86] Henseler, J., Ringle, C.M., and Sinkovics, R.R. The use of partial least squares path modeling in international marketing. *Advances in International Marketing 20*, 20 (2009), 277–319.

[87] Hinton, R.H., Brownlow, C., McMurray, I., and Cozens, B. *SPSS Explained*. Routledge, 2004.

[88] Hirsh, J.B., Kang, S.K., and Bodenhausen, G. V. Personalized persuasion: tailoring persuasive appeals to recipients' personality traits. *Psychological Science 23*, 6 (2012), 578–81.

[89] Hoffman, H.G., Patterson, D.R., Seibel, E., Soltani, M., Jewett-Leahy, L., and Sharar, S.R. Virtual reality pain control during burn wound debridement in the hydrotank. *The Clinical Journal of Pain 24*, 4 (2008), 299–304.

[90] Hofstede, G. *Cultures And Organizations - Software of the Mind*. New York: McGraw-Hill, 1996.

[91] Holm, S. A Simple Sequentially Rejective Multiple Test Procedure. *Scandinavian Journal of Statistics 6*, 2 (1979), 65–70.

[92] Hoysniemi, J. International survey on the Dance Dance Revolution game. *Computers in Entertainment 4*, 2 (2006), 8.

[93] Hunter, J.E. and Schmidt, F.L. *Methods of Meta-Analysis: Correcting Error and Bias in Research Findings*. Sage Publications, 1990.

[94] James, D., Pobee, J., Brown, L., and Joshi, G. Using the Health Belief Model to Develop Culturally Appropriate Weight-Management Materials for African-American Women. *Journal of Academy of Nutrition and Dietetics 112*, 5 (2012), 664–70.

[95] Kähkönen, P., Tuorila, H., and Rita, H. How information enhances acceptability of a low-fat spread. *Food Quality and Preference 7*, 2 (1996), 87–94.

[96] Kaipainen, K., Payne, C.R., and Wansink, B. Mindless eating challenge: retention, weight outcomes, and barriers for changes in a public web-based healthy eating and weight loss program. *Journal of medical Internet research 14*, 6 (2012), e168.

[97] Kaipainen, K., Payne, C.R., and Wansink, B. Mindless eating challenge: retention, weight outcomes, and barriers for changes in a public web-based healthy eating and weight loss program. *Journal of medical Internet Research 14*, 6 (2012), e168.

[98] Kaiser, H.F. The appliation of electronic computers to factor analysis. *Educational and Psychological Measurement 20*, (1960), 141–151.

[99] Kaiser, H.F. A second generation little jiffy. *Psychometrika 35*, 4 (1970), 401–415.

[100] Kaptein, M., Duplinsky, S., and Markopoulos, P. Means based adaptive persuasive systems. *Proceedings of the 2011 Annual Conference on Human Factors in Computing Systems*, (2011), 335.

[101] Kaptein, M. and Eckles, D. Selecting effective means to any end: Futures and ethics of persuasion profiling. *Proceedings of the International Conference on Persuasive Technology*, (2010).

[102] Kaptein, M., Lacroix, J., and Saini, P. Individual differences in persuadability in the health promotion domain. *Proceedings of the International Conference on Persuasive Technology*, (2010), 94–105.

[103] Kaptein, M., De Ruyter, B., Markopoulos, P., and Aarts, E. Adaptive Persuasive Systems. *ACM Transactions on Interactive Intelligent Systems 2*, 2 (2012), 1–25.

[104] Kaptein, M. Personalized persuasion in Ambient Intelligence. *Journal of Ambient Intelligence and Smart Environments 4*, 2012, 279–280. http://iospress.metapress.com/index/8673017ML2543812.pdf.

[105] Kato, P.M., Cole, S.W., Bradlyn, A.S., and Pollock, B.H. A video game improves behavioural outcomes in adolescents and young adults with cancer: a randomized trial. *Pediatrics 122*, 2 (2008), e305–17.

[106] Kato, P.M. Video games in health care: Closing the gap. *Review of General Psychology 14*, 2 (2010), 113–121.

[107] Kearney, J.M., Gibney, M.J., Livingstone, B.E., Robson, P.J., Kiely, M., and Harrington, K. Attitudes towards and beliefs about nutrition and health among a random sample of adults in the Republic of Ireland and Northern Ireland. *Public Health Nutrition 4*, 5A (2001), 1117–26.

[108] Khaled, R., Barr, P., and Biddle, R. Game design strategies for collectivist persuasion. *Proceedings of the 2009 ACM SIGGRAPH Symposium on Video Games*, (2009), 31–38.

[109] Khaled, R., Barr, P., and Fischer, R. Factoring culture into the design of a persuasive game. *Conference on Computer-Human Interaction: Design: Activities, Artefacts and Environments*, (2006), 213–220.

[110] Khaled, R., Barr, P., Noble, J., Fischer, R., and Biddle, R. Fine tuning the persuasion in persuasive games. *Proceedings of the International Conference on Persuasive Technology*, (2007), 36–47.

[111] Khaled, R., Biddle, R., and Noble, J. Persuasive interaction for collectivist cultures. *Proceedings of the 7th Australia User Interface Conference*, (2006), 73 – 80.

[112] Khaled, R. Culturally-Relevant Persuasive Technology. *A thesis submitted to the Victoria University ofWellington*, (2008).

[113] Kharrazi, H. and Faiola, A. Healthcare Game Design: Behavioural Modeling of Serious Gaming Design for Children with Chronic Diseases. *Human-Computer Interaction.*, (2009), 1–10.

[114] Kim, H.-S., Ahn, J., and No, J.-K. Applying the Health Belief Model to college students' health behaviour. *Nutrition Research and Practice 6*, 6 (2012), 551–8.

[115] Kim, M.-S. and Hunter, J.E. Relationships Among Attitudes, Behavioural Intentions, and Behaviour: A Meta-Analysis of Past Research, Part 2. *Communication Research 20*, 3 (1993), 331–364.

[116] King, P. and Tester, J. The landscape of persuasive technologies. *Communications of the ACM 42*, 5 (1999), 31–38.

[117] Kohn, A. *No Contest: The Case Against Competition*. Houghton Mifflin, 2006.

[118] Kraus, S.J. Attitudes and the Prediction of Behaviour: A Meta-Analysis of the Empirical Literature. *Personality and Social Psychology Bulletin 21*, 1 (1995), 58–75.

[119] Kuittinen, J., Kultima, A., Niemelä, J., and Paavilainen, J. Casual games discussion. *Proceedings of the 2007 Conference on Future Play - Future Play '07*, (2007), 105.

[120] Kupek, E. Beyond logistic regression: structural equations modelling for binary variables and its application to investigating unobserved confounders. *BMC Medical Research Methodology 6*, 1 (2006), 13.

[121] Lau, D.C.W., Douketis, J.D., Morrison, K.M., Hramiak, I.M., Sharma, A.M., and Ur, E. 2006 Canadian clinical practice guidelines on the management and prevention of obesity in adults and children [summary]. *CMAJ : Canadian Medical Association journal = journal de l'Association medicale canadienne 176*, 8 (2007), S1–13.

[122] Lehto, T. and Oinas-kukkonen, H. Persuasive Features in Six Weight Loss Websites : A Qualitative Evaluation. *Proceedings of the International Conference on Persuasive Technology*, (2010), 162–173.

[123] Lelie, C. The value of storyboards in the product design process. *Personal and Ubiquitous Computing 10*, 2-3 (2005), 159–162.

[124] Lewis, C. *Using the "thinking Aloud" Method in Cognitive Interface Design*. IBM T.J. Watson Research Center, 1982.

[125] Lewis, S., Dontcheva, M., and Gerber, E. Affective computational priming and creativity. *Proceedings of the 2011 Annual Conference On Human Factors In Computing Systems - CHI '11*, ACM Press (2011), 735.

[126] Li, K. a. and Counts, S. Exploring social interactions and attributes of casual multiplayer mobile gaming. *Proceedings of the 4th international Conference On Mobile Technology, Applications, and Systems and The 1st International Symposium On Computer Human Interaction in Mobile Technology - Mobility '07 07*, (2007), 696.

[127] Lieberman, D.A. Management of chronic pediatric diseases with interactive health games: theory and research findings. *The Journal of Ambulatory Care Management 24*, 1 (2001), 26–38.

[128] Lin, J., Mamykina, L., Lindtner, S., Delajoux, G., and Strub, H. Fish'n'Steps: Encouraging physical activity with an interactive computer game. *UbiComp 2006: Ubiquitous Computing*, (2006), 261–278.

[129] Liu, P. and Kwon, J. Perceived Availability of and Attitudes toward Healthy Food Choices in Assisted-Living Facilities in Kansas. *Journal of Foodservice Business Research 16*, 2 (2013), 183–196.

[130] Maddock, J. The relationship between obesity and the prevalence of fast food restaurants: state-level analysis. *American Journal Of Health Promotion : AJHP 19*, 2, 137–43.

[131] Mason, W. and Suri, S. Conducting behavioural research on Amazon's Mechanical Turk. *Behaviour Research Methods 44*, 1 (2012), 1–23.

[132] McAuley, E., Duncan, T., and Tammen, V. V. Psychometric Properties of the Intrinsic Motivation Inventory in a Competitive Sport Setting: A Confirmatory Factor Analysis. *Research Quarterly for Exercise and Sport 60*, 1 (1989), 48–58.

[133] McGraa, L.K. *The Effects of Persuasive Motivational Text Messaging on Adherence to Diet and Exercise Programs Across Different Personality Traits.* Proquest, Umi Dissertation Publishing, 2011.

[134] Michie, S., Johnston, M., Francis, J., Hardeman, W., and Eccles, M. From Theory to Intervention: Mapping Theoretically Derived Behavioural Determinants to Behaviour Change Techniques. *Applied Psychology 57*, 4 (2008), 660–680.

[135] Myers, I.B. and McCaulley, M.H. *Manual: A Guide to the Development and Use of the Myers-Briggs Type Indicator*. Consulting Psychologists Press, 1985.

[136] Nacke, L., Bateman, C., and Mandryk, R. BrainHex: Preliminary Results from a Neurobiological Gamer Typology Survey. *Entertainment Computing–ICEC 2011*, (2011), 1–6.

[137] Nacke, L.E., Bateman, C., and Mandryk, R.L. BrainHex: A Neurobiological Gamer Typology Survey. *Entertainment Computing*, June (2013).

[138] Noar, S.M., Benac, C.N., and Harris, M.S. Does tailoring matter? Meta-analytic review of tailored print health behaviour change interventions. *Psychological bulletin 133*, 4 (2007), 673–93.

[139] Oinas-Kukkonen, H. and Harjumaa, M. A systematic framework for designing and evaluating persuasive systems. *Proceedings of the International Conference on Persuasive Technology*, (2008), 164–176.

[140] Oinas-Kukkonen, H. and Harjumaa, M. Persuasive systems design: Key issues, process model, and system features. *Communications of the Association for Information Systems 24*, 1 (2009), 28.

[141] Ong, T.F. and Musa, G. Examining the influences of experience, personality and attitude on SCUBA divers' underwater behaviour: A structural equation model. *Tourism Management 33*, 6 (2012), 1521–1534.

[142] Orji, R., Mandryk, R., and Vassileva, J. Towards a data-driven approach to intervention design: a predictive path model of healthy eating determinants. *7th International Conference on Persuasive Technology Design for Health and Safety, Design for Health and Safety,*, (2012), 203–214.

[143] Orji, R., Mandryk, R.L., Vassileva, J., and Gerling, K.M. Tailoring persuasive health games to gamer type. *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems - CHI '13*, ACM Press (2013), 2467–2476.

[144] Orji, R., Vassileva, J., and Mandryk, R. Towards an effective health interventions design: an extension of the health belief model. *Online Journal of Public Health Informatics 4*, 3 (2012).

[145] Orji, R., Vassileva, J., and Mandryk, R.L. LunchTime: a slow-casual game for long-term dietary behaviour change. *Personal and Ubiquitous Computing*, (2012), 10.1007/s00779–012–0590–6.

[146] Orji, R.O., Vassileva, J., and Mandryk, R.L. Modeling Gender Differences in Healthy Eating Determinants for Persuasive Intervention Design. *Proceedings of the International Conference on Persuasive Technology*, *7822*, (2013), 161–173.

[147] Pallant, J. *SPSS Survival Manual: A Step by Step Guide to Data Analysis Using SPSS*. Open University Press4, 2010.

[148] Parker, A., McClendon, I., and Grevet, C. I am what i eat: identity & critical thinking in an online health forum for kids. *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems - CHI '13*, ACM Press (2013), 2437-2446.

[149] Peng, W. Design and evaluation of a computer game to promote a healthy diet for young adults. *Health communication 24*, 2 (2009), 115–27.

[150] Poirier, J. and Cobb, N.K. Social influence as a driver of engagement in a web-based health intervention. *Journal of Medical Internet research 14*, 1 (2012), e36.

[151] Pollak, J., Gay, G., Byrne, S., Wagner, E., Retelny, D., and Humphreys, L. It;s Time to Eat; Using Mobile Games to Promote Healthy Eating. *{IEEE} Pervasive Computing 9*, 3 (2010), 21–27.

[152] Poole, S. *Trigger Happy: Videogames and the Entertainment Revolution*. Arcade Publishing, 2004.

[153] Prochaska, J.O., DiClemente, C.C., and Norcross, J.C. In Search of How People Change Applications to Additive Behaviours. *American Psychology 47*, 9 (1992), 1102 –1114.

[154] Purpura, S., Schwanda, V., Williams, K., Stubler, W., and Sengers, P. Fit4Life : The Design of a Persuasive Technology Promoting Healthy Behaviour and Ideal Weight. *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems - CHI '11*, ACM Press, (2011) 423-432.

[155] Reinwand, D., Kuhlmann, T., Wienert, J., de Vries, H., and Lippke, S. Designing a theory- and evidence-based tailored eHealth rehabilitation aftercare program in Germany and the Netherlands: study protocol. *BMC Public Health 13*, 1 (2013), 1081.

[156] Rigby, S. and Ryan, R. *Glued to Games: How Video Games Draw Us In and Hold Us Spellbound*. Greenwood Publishing Group, 2011.

[157] Ringle, C.M., Wende, S., and Becker, J. smartpls.de - next generation path modeling. Accessed Dec. 2012. http://www.smartpls.de/forum/contact.php.

[158] Rosenstock, I.M. Why people use health services. *The Milbank Memorial Fund quarterly 44*, 3 (1966), Suppl:94–127.

[159] Ryan, R. Control and information in the intrapersonal sphere: An extension of cognitive evaluation theory. *Journal of Personality And Social Psychology 43*, 3 (1982), 450–461.

[160] Ryan, R.M., Rigby, C.S., and Przybylski, A. The Motivational Pull of Video Games: A Self-Determination Theory Approach. *Motivation and Emotion 30*, 4 (2006), 344–360.

[161] Sapp, S.G. and Jensen, H.H. An Evaluation of the Health Belief Model for Predicting Perceived and Actual Dietary Quality. *Journal of Applied Social Psychology 28*, 3 (1998), 235–248.

[162] Schwarzer, R. and Fuchs, R. Self-efficacy and health behaviours. In M. Conner and P. Norman, eds., *Predicting Health Behaviour*. Buckingham, UK: Open University Press, 1996, 163–196.

[163] Segerståhl, K., Kotro, T., Kaisa, V., and Mattila, V. Pitfalls in persuasion: how do users experience persuasive techniques in a web service? *Proceedings of the International Conference on Persuasive Technology*, (2010), 211–222.

[164] Setterstrom, A.J., Pearson, J.M., and Aleassa, H. An Exploratory Examination of Antecedents to Software Piracy: A Cross-Cultural Comparison. *2012 45th Hawaii International Conference on System Sciences*, (2012), 5083–5092.

[165] Shegog, R. Application of behavioural theory in computer game design for health behaviour change. *Serious Game Design & Development. Technologies for training and learning*, (2010), 196–232.

[166] Sherman, D.K., Mann, T., and Updegraff, J. a. Approach/Avoidance Motivation, Message Framing, and Health Behaviour: Understanding the Congruency Effect. *Motivation and Emotion 30*, 2 (2006), 165–169.

[167] Van Sluijs, E.M.F., Van Poppel, M.N.M., Twisk, J.W.R., Brug, J., and Van Mechelen, W. The positive effect on determinants of physical activity of a tailored, general practice-based physical activity intervention. *Health Education Research 20*, 3 (2005), 345–56.

[168] Steimann F., Kahkonen P., Tuorila H., and Rita H. How information enhances acceptability of a low-fat spread. *Food Quality and Preference 7*, 2 (1996), 8.

[169] Steinmetz, H., Schmidt, P., Tina-Booh, A., Wieczorek, S., and Schwartz, S.H. Testing measurement invariance using multigroup CFA: differences between educational groups in human values measurement. *Quality & Quantity 43*, 4 (2008), 599–616.

[170] Steptoe, A., Pollard, T., and Wardle, J. Development of a measure of the motives underlying the selection of food: the food choice questionnaire. *Appetite*, (1995), 267–284.

[171] Stewart, B. Personality And Play Styles: A Unified Model. *Gamasutra the Art & Business of Making Games*. Accessed January, 2013. http://www.gamasutra.com/view/feature/6474/personality_and_play_styles_a_.php?print=1.

[172] Stokes, B. Videogames have changed: time to consider 'Serious Games'? *The Development Education Journal*, (2005), 6–13.

[173] Sun, Y.-H.C. Health concern, food choice motives, and attitudes toward healthy eating: the mediating role of food choice motives. *Appetite 51*, 1 (2008), 42–9.

[174] Sundar, S.S., Bellur, S., and Jia, H. Motivational Technologies: A Theoretical Framework for Desiging Preventive Health Application. *Proceedings of the International Conference on Persuasive Technology,7284*, (2012), 112–122.

[175] Sundar, S.S. and Marathe, S.S. Personalization versus Customization: The Importance of Agency, Privacy, and Power Usage. *Human Communication Research 36*, 3 (2010), 298–322.

[176] Sutton, S. Predicting and Explaining Intentions and Behaviour: How Well Are We Doing? *Journal of Applied Social Psychology 28*, 15 (1998), 1317–1338.

[177] Tan, C.S.S., Schöning, J., Barnes, J.S., Luyten, K., and Coninx, K. Bro-cam: improving game experience with empathic feedback using posture tracking. *Proceedings of the International Conference on Persuasive Technology*, Springer Berlin Heidelberg (2013), 222–233.

[178] Tao, S. Values and Lifestyles of Individualists and Collectivists: A Cross-culture Study on Taiwanese and US Consumers. *Fuxinggang Journal*, (2005), 411–438.

[179] Teng, C. Online Game Player Personality and Real-life Need Fulfillment. *International Journal of Cyber Society and Education, 2, 2 (2009), 39–50.*

[180] Thompson, D. and Baranowski, T. Serious Video Games for Health: How Behavioural Science Guided the Development of a Serious Video Game. *Simulation Gaming 41*, 4 (2010), 587–606.

[181] Tinsley, H.E.A. and Tinsley, D.J. Uses of Factor Analysis in Counseling Psychology Research. *Journal of Counseling Psychology 34*, 4 (1987), 414–24.

[182] Torning, K., Hall, C., and Oinas-kukkonen, H. Persuasive System Design : State of the Art and Future Directions. *Information Systems*, (2009).

[183] Toscos, T., Faber, A., An, S., and Gandhi, M.P. Chick clique: persuasive technology to motivate teenage girls to exercise. *{CHI} '06 Extended Abstracts on Human Factors In Computing Systems*, ACM (2006), 1873–1878.

[184] Triandis, H. *Individualism and Collectivism*. Westview Press, 1995.

[185] Truong, K., Hayes, G., and Abowd, G. Storyboarding: an empirical determination of best practices and effective guidelines. *Proceedings of the Conference on Designing Interactive systems*, (2006), 12–21.

[186] Tsai, C.C., Lee, G., Raab, F., et al. Usability and Feasibility of PmEB: A Mobile Phone Application for Monitoring Real Time Caloric Balance. *Mobile Networks and Applications 12*, 2-3 (2007), 173–184.

[187] Vaughn, M.L., Jacquez, F., and Baker, R.C. Cultural Health Attributions, Beliefs, and Practices: Effects on Healthcare and Medical Education. *The Open Medical Education Journal 2*, (2009), 64–74.

[188] Verplanken, B. and Faes, S. Good intentions, bad habits, and effects of forming implementation intentions on healthy eating. *European Journal of Social Psychology 29*, (1999), 591–604.

[189] Vilozni, D., Barker, M., Jellouschek, H., Heimann, G., and Blau, H. An interactive computer-animated system (SpiroGame) facilitates spirometry in preschool children. *American journal Of Respiratory and Critical Care Medicine 164*, 12 (2001), 2200–5.

[190] W3C. An SVG Primer for Today's Browsers. 2010. Accessed June, 2012 http://www.w3.org/Graphics/SVG/IG/resources/svgprimer.html.

[191] Wang, H. Game Reward Systems : Gaming Experiences and Social Meanings. *Proceedings of DiGRA 2011 Conference: Think Design Play*. (2011), 1-15.

[192] Wansink, B. *Mindless Eating: Why We Eat More Than We Think*. Bantam, 2006.

[193] Wiafe, I., Nakata, K., Moran, S., and Gulliver, S. Considering user attitude and behaviour in persuasive systems design: The 3D-RAB model. *AIS Electronic Library* (2011).

[194] Wiafe, I. and Nakata, K. Bibliographic Analysis of Persuasive Systems: Techniques, Methods and Domains of Application. *Proceedings of the International Conference on Persuasive Technology*, (2012), 61 – 64.

[195] Winett, R.A., Wagner, J.L., Moore, J.F., et al. An experimental evaluation of a prototype public access nutrition information system for supermarkets. *Health Psychology : Official Journal of the Division of Health Psychology, American Psychological Association 10*, 1 (1991), 75–8.

[196] Yee, N., Ducheneaut, N., and Nelson, L. Online gaming motivations scale: development and validation. *Proceedings of the SIGCHI Conference on Human Factors In Computing Systems*, (2012), 2803–2806.

[197] Yee, N. Motivations of Play in MMORPGs. *Proceedings of DiGRA 2005 Conference*, (2005), 1-8.

[198] Yee, N. The Demographics, Motivations, and Derived Experiences of Users of Massively Multi-User Online Graphical Environments. *Presence: Teleoperators and Virtual Environments 15*, 3 (2006), 309–329.

[199] Zammitto, V. Gamers' personality and their gaming preferences. *Thesis Submitted to the School of Interactive Arts and Technology, University of Belgrano,* (2010).

[200] Game Food Pyramid, USA: Playnormous. Accessed January, 2011 http://www.playnormous.com/games/index.cfm.

[201] BrainHex. Accessed January, 2011. http://blog.brainhex.com/. Accessed January, 2011

[202] SCVNGR's Secret Game Mechanics Playdeck | TechCrunch. Accessed December, 2011. http://techcrunch.com/2010/08/25/scvngr-game-mechanics/.

[203] Game Mechanics | Gamification.org. http://gamification.org/wiki/Game_Mechanics. Accessed June, 2013

[204] BBC Science - Healthy living: How to live longer. *Science Knowledge & Learning Beta*, 2013. http://www.bbc.co.uk/science/0/22019289. Accessed March, 2014.

APPENDIX

STUDY INSTRUMENTS

Demographic Questions

1. Please choose your age bracket: *

- Under 18
- 18-25
- 26-35
- 36-45
- Over 46

2. Do you ever play phone, computer or video games? *

- Yes
- No

3. Please choose your sex: *

- Male
- Female

4. What is the highest level of education you have attained?

- Less than high school
- High school graduate
- College diploma
- Bachelor's degree
- Master's Degree
- Doctorate degree
- Other:

5. What is your nationality?.................................

6. Which Geographical Territory are you from: *(Geographical territory of origin)

- North America
- Southern or Central America
- Western Europe or UK
- Eastern Europe or Russia
- Southern Europe/Mediterranean
- South Asia (incl. China, India and Japan)
- Africa
- Middle East
- Australasia
- Other:

7. I typically play computer or videogames: *

- Every day
- A few times per week
- Once per week
- A few times per month
- Once per month
- A few times per year
- Once per year or less

8. I would consider myself *

- Hardcore gamer
- Something between a Hardcore and a Casual gamer
- Casual gamer
- I have no idea!

Self-efficacy

32. Please rate your level of agreement with the following statements in a 7-point scale. Choosing 1-Strongly Disagree to 7-Strongly Agree.

	1-Strongly disagree						**7-Strongly agree**
If I want, I could easily eat healthily within the next two weeks	1	2	3	4	5	6	7
I have control over whether or not I eat healthily	1	2	3	4	5	6	7
Whether or not I eat healthy diets in the next week is entirely up to me	1	2	3	4	5	6	7
I believe I have the ability to eat healthy diet next week	1	2	3	4	5	6	7
I am confident that I could eat healthily within the next two weeks if I want	1	2	3	4	5	6	7

Attitude

Eating healthy food in the next two weeks would be:								
Unimportant	1	2	3	4	5	6	7	Important
Useless	1	2	3	4	5	6	7	Useful
Worthless	1	2	3	4	5	6	7	Valuable
Unenjoyable	1	2	3	4	5	6	7	Enjoyable
Harmful	1	2	3	4	5	6	7	Beneficial
Unpleasant	1	2	3	4	5	6	7	Pleasant
Bad	1	2	3	4	5	6	7	Good

Susceptibility

If I don’t eat healthily, there is a good possibility that I will gain weight in the next 3 months.	1	2	3	4	5	6	7
If I don’t stick to a healthy diet, I will be at high risk for some diet related diseases.	1	2	3	4	5	6	7

Severity

The thought of ending up in the hospital due to diet related diseases scares me.	1	2	3	4	5	6	7
If I gain weight in the next 3 months, it will be a bad thing.	1	2	3	4	5	6	7

Perceived Benefit

44. On a scale of 1 to 7, how much do you agree or disagree that eating healthy diets most of the time would

	5-Strongly agree					**5-Strongly agree**	
Be beneficial to you	1	2	3	4	5	6	7
Help you maintain your general health	1	2	3	4	5	6	7
Decrease your chances of becoming obese/overweight	1	2	3	4	5	6	7
Decrease your chances of getting heart disease	1	2	3	4	5	6	7
Decrease your chances of getting cancer	1	2	3	4	5	6	7
Decrease your chances of getting high blood pressure	1	2	3	4	5	6	7
Decrease your chances of becoming diabetic	1	2	3	4	5	6	7

Perceived Barrier

1-Strongly disagree						**7- Strongly agree**	
Eating a healthy diet is costly.	1	2	3	4	5	6	7
Eating a healthy diet is hard.	1	2	3	4	5	6	7
There are so many recommendations on what constitutes a healthy diet; it’s hard to know what to believe.	1	2	3	4	5	6	7
Healthy diets are not as tasty as the unhealthy options.	1	2	3	4	5	6	7
Healthy diets are not as satisfying as the unhealthy options.	1	2	3	4	5	6	7
Healthy diets are not readily available in most places most of the time.	1	2	3	4	5	6	7
It will be hard for me to change my diet.	1	2	3	4	5	6	7

Intention to Eat Healthy

	1-Extremely unlikely						7-Extremely likely
I intend to avoid eating junk and fast food during the next two weeks	1	2	3	4	5	6	7
I intend to eat more vegetable during the next two weeks	1	2	3	4	5	6	7
I will try to eat only a healthy amount of fat during the next two weeks	1	2	3	4	5	6	7
I intend to eat more fruits during the next two weeks	1	2	3	4	5	6	7
I intend to eat healthily during the next two weeks	1	2	3	4	5	6	7
I will try to eat healthily during the next two weeks	1	2	3	4	5	6	7
I plan to eat healthily during the next two weeks	1	2	3	4	5	6	7

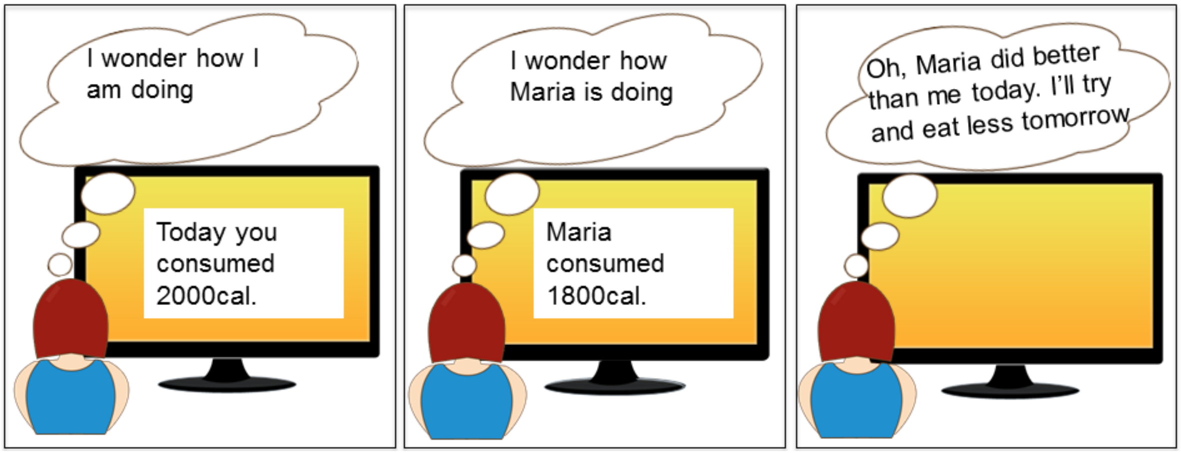
Cue to Action

	1- Strongly disagree						7- Strongly agree
33. I would pay more attention to my food choices if friends and family members suggest it I	1	2	3	4	5	6	7
34. I would pay more attention to my food choices if recommended by a doctor	1	2	3	4	5	6	7
35. I will eat healthily if people who are important to me are worried about my health. *	1	2	3	4	5	6	7
36. I would pay more attention to my food choices if I read information about the nutrition contents. *	1	2	3	4	5	6	7

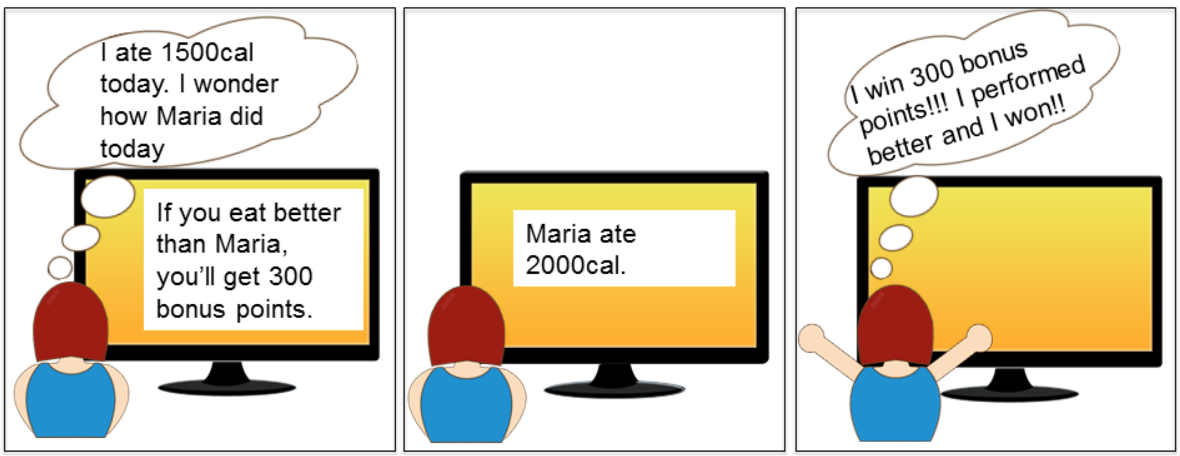
The Intrinsic Motivation Inventory (IMI) Scale used in evaluating player experience and the BrainHex Scales used in classifying games to their various types can be obtained from the links below with permission from the authors:

IMI Scale: http://www.selfdeterminationtheory.org/questionnaires/10-questionnaires/50

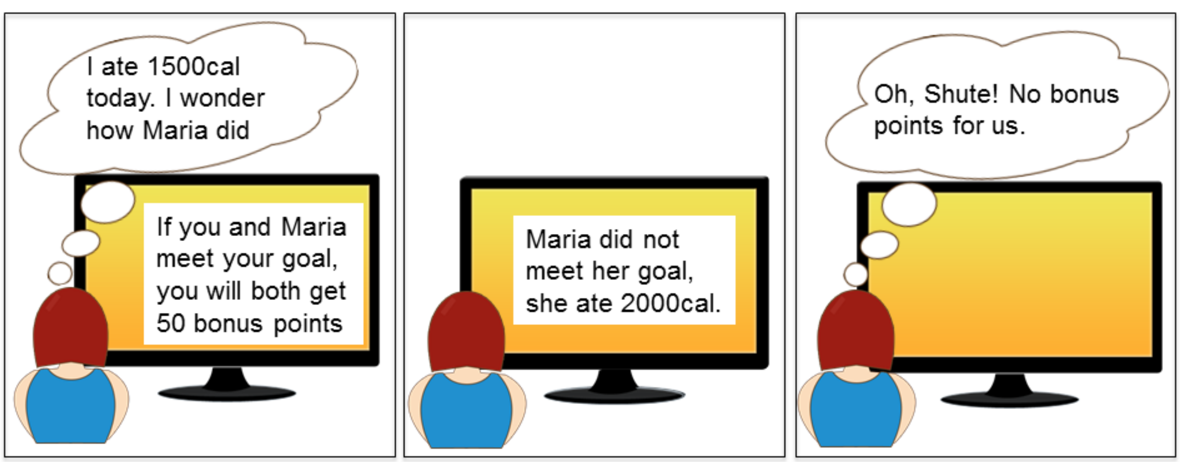
BrainHex Gamer Type Scales: http://survey.ihobo.com/BrainHex/



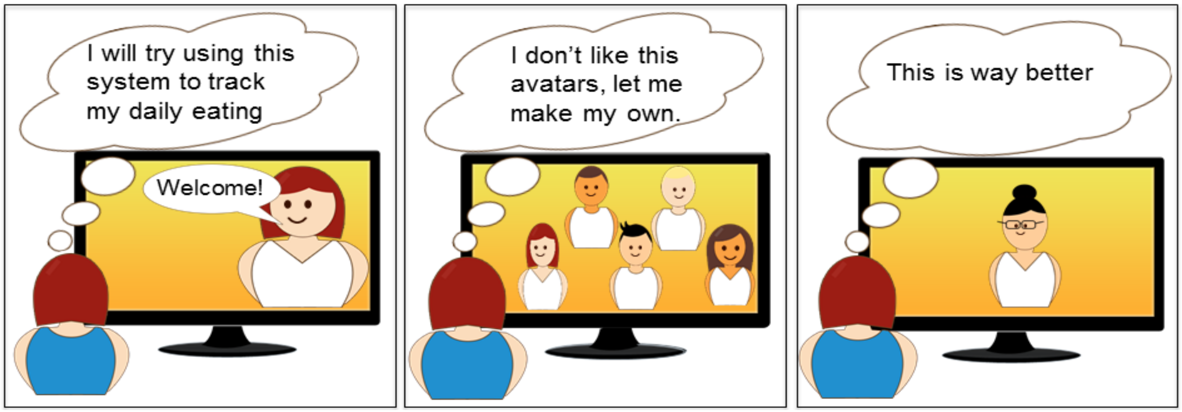
Storyboard Illustrating Comparison Strategy



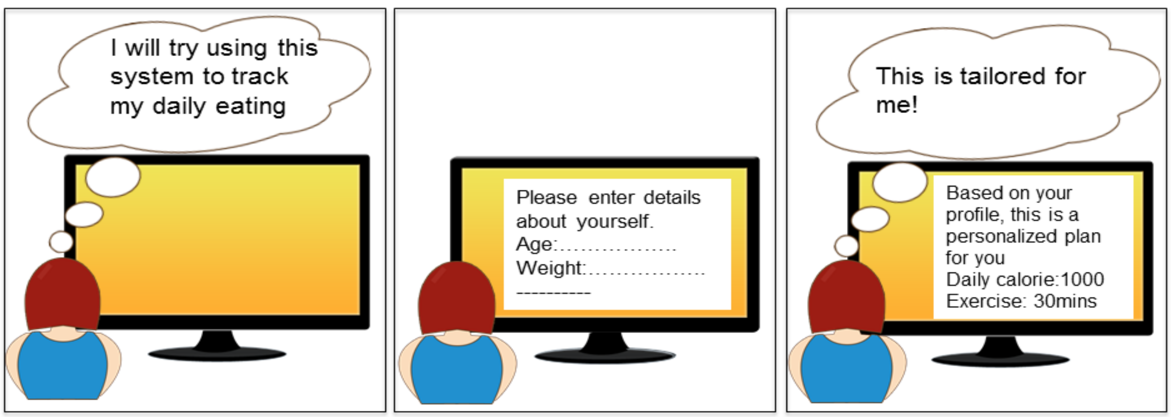
Storyboard Illustrating Competition Strategy



Storyboard Illustrating Cooperation Strategy

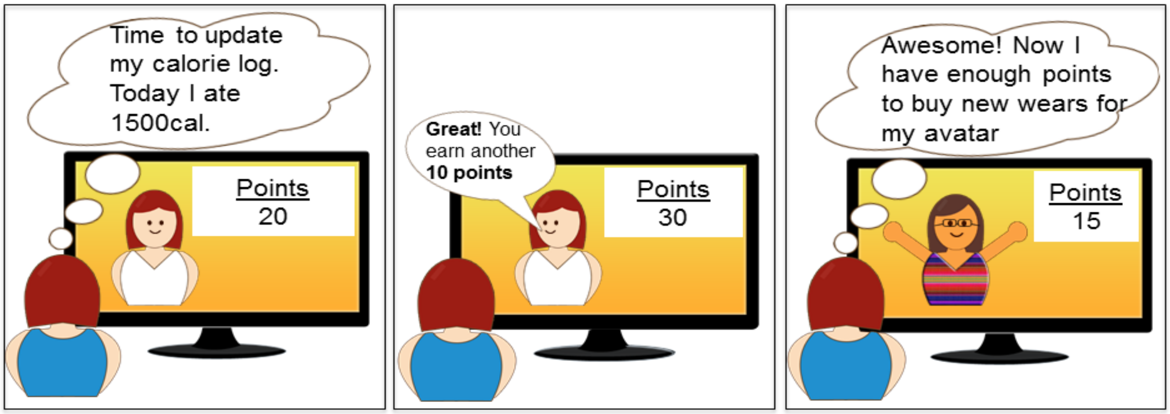


Storyboard Illustrating Customization Strategy

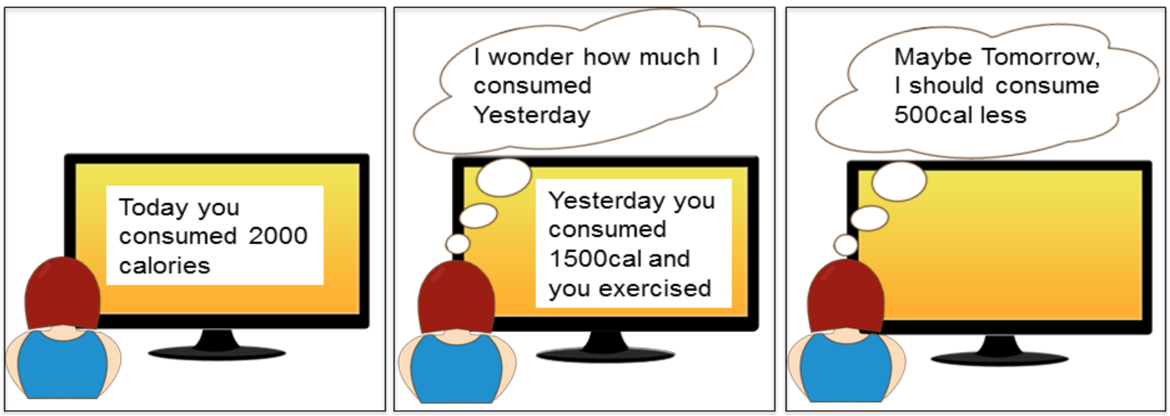


Storyboard Illustrating Personalization Strategy

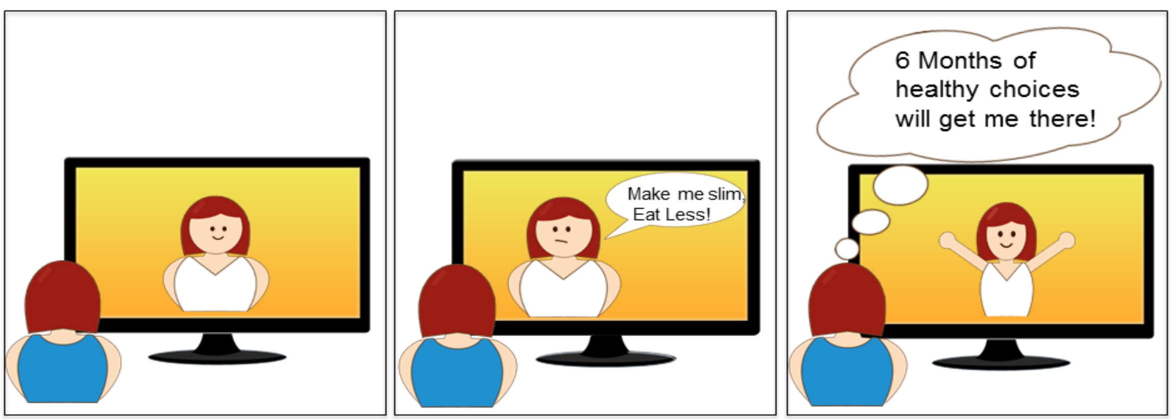
Storyboard Illustrating Praise Strategy



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).

1. 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.**

STUDY CONSENT FORMS

UNIVERSITY OF SASKATCHEWAN

You are invited to participate in this survey aiming at identifying effective ways of designing interventions to promote healthier lifestyle especially when eating in the restaurants.

Please read this form carefully, and feel free to ask the researchers any questions you might have.

Title of Study: Understanding Users' Behavior and Attitude towards Fast Food

Ethics Application Number: 08-69

Researcher(s): Dr. Regan Mandryk, Department of Computer Science, (966-4888), regan@cs.usask.ca

Dr Julita Vassileva, Department of Computer Science (966-2073), jiv@cs.usask.ca

Rita Orji, Department of Computer Science (880-8087), rita.orji@usask.ca

Purpose and Procedure: The goal of this research is to identify effective methods for designing intervention to promote healthy lifestyle especially when eating in the fast food restaurants. In particular, the study seeks to understand the general attitude, health concern, nutrition knowledge, and how decisions about meal choices are made. The study may contribute to the research area of Persuasive Technology for Healthy Behavior Change and User Modelling, Adaption, and Personalization. To achieve this, we have designed a set of questions that we need you to respond to.

Potential Benefits: Findings from the study could lead to a better understanding of the type of technological intervention most suitable for encouraging healthy eating behavior.

Potential Risks: There are no known risks in this study.

Confidentiality: Once you sign the consent form, we will not require any personal identifiable information such as name, NSID, emails, etc.

Dissemination of Results: Aggregated results derived from this study will appear in a PhD thesis and articles published in peer reviewed conferences and scientific journals. However, any information that can be linked to a specific participant will be removed or altered and any quotations from participants that are published will be so only if no linkage can reasonably be made to the participant in any way.

Right to Withdraw: Your participation in this study is voluntary, and you may withdraw from the study for any reason, at any time, without penalty of any sort. You may refuse to answer individual questions. If you withdraw from the study at any time, any data that you have contributed will be destroyed at your request.

Questions: If you have any questions concerning the research project, please feel free to ask at any point; you are also free to contact the researchers at the numbers provided above or via email (regan@cs.usask.ca, jiv@cs.usask.ca, rita.orji@usask.ca). This research project has been approved on ethical grounds by the University of Saskatchewan Behavioural Research Ethics Board. Any questions regarding your rights as a participant may be addressed to that committee through the Ethics Office (966-2084). Out of town participants may call collect.

Follow-Up or Debriefing: If you would like to know the results of this study, you can contact the researchers

Consent to Participate:

I have read and understood the description provided. I have had an opportunity to ask questions and my questions have been answered. I consent to participate in the survey, understanding that I may withdraw my consent any time before or during the study and within one week after the study. A copy of this Consent Form has been given to me for my records.

○ I consent ○ I don't consent

UNIVERSITY OF SASKATCHEWAN

You are invited to participate in a research project for identifying effective ways to design game-based interventions to promote a healthier lifestyle, especially as relates to healthy eating.

Please read this form carefully, and feel free to ask the researchers any questions you might have.

Title of Study: Understanding Persuasive Strategies and Gamer Types

Ethics Application Number: 08-69

Researcher(s): Dr. Regan Mandryk, Department of Computer Science, (966-4888), regan@cs.usask.ca
Dr Julita Vassileva, Department of Computer Science (966-2073), jiv@cs.usask.ca
Rita Orji, Department of Computer Science (880-8087), rita.orji@usask.ca

Purpose and Procedure: The goal of the research is to identify effective methods for designing game-based interventions to promote a healthy lifestyle – especially healthy eating behavior. In particular, the study seeks to identify various gamer types and their opinions about certain game play motivation strategies. The study may contribute to the research area of Persuasive Technology for motivating healthy behavior, particularly to issues supporting designing effective games for promoting healthy behavior. To do this we have designed storyboards of various strategies and a set of questions that we need you to respond to.

Potential Benefits: Findings from the study could lead to a better understanding of the type of game-based intervention that is suitable for encouraging healthy eating behavior for various gamer types

Potential Risks: There are no known risks in this study.

Confidentiality: Once you sign the consent form, we will not require any personal identifiable information such as name, emails, etc.

Dissemination of Results: Aggregated results derived from this study will appear in in a PhD thesis and articles published in peer reviewed conferences and scientific journals. However, any information that can be linked to a specific participant will be removed or altered and any quotations from participants that are published will be so only if no linkage can reasonably be made to the participant in any way.

Right to Withdraw: Your participation in this study is voluntary, and you may withdraw from the study for any reason, at any time but only completed and submitted HITs receive Turk payment.

Questions: If you have any questions concerning the research project, please feel free to ask at any point; you are also free to contact the researchers at the numbers provided above or via email (regan@cs.usask.ca, jiv@cs.usask.ca, rita.orji@usask.ca). This research project has been approved on ethical grounds by the University of Saskatchewan Behavioral Research Ethics Board. Any questions regarding your rights as a participant may be addressed to that committee through the Ethics Office (966-2084). Out of town participants may call collect.

Follow-Up or Debriefing: If you would like to know the results of this study, you can contact the researchers

Consent to Participate:

I have read and understood the description provided; I have had an opportunity to ask questions and my/our questions have been answered. I consent to participate in the research project, understanding that I may withdraw my consent any time before and during the study and within one week after the study. You can print a copy of this Consent Form for you records.

○ I consent ○ I don't consent

UNIVERSITY OF SASKATCHEWAN

You are invited to participate in this study aiming at identifying strategies for designing effective game-based intervention for promoting healthy behavior.

Please read this form carefully, and feel free to ask the researchers any questions you might have.

Title of Study: Designing Effective Game-based Interventions

Ethics Application Number:08-69

Researcher(s): Dr. Regan Mandryk, Department of Computer Science, (306-966-4888), regan@cs.usask.ca

Dr Julita Vassileva, Department of Computer Science (306-966-2073), jiv@cs.usask.ca

Rita Orji, Department of Computer Science (306-880-8087), rita.orji@usask.ca

Purpose and Procedure: The goal of this study is to identify effective methods for designing intervention to promote healthy lifestyle. In particular, the study seeks to understand the strategies the could be used for designing effective game-based intervention for promoting healthy behavior (especially healthy eating) for various gamer types. The study may contribute to the research area of Persuasive Technology for Healthy Behavior Change and User modelling, adaptation, and personalization. To achieve this, we have designed a set of questions that we need you to respond to.

Potential Benefits: Findings from the study could lead to a better understanding of the type of technological intervention most suitable for encouraging healthy eating behavior.

Potential Risks: There are no known risks in this study.

Confidentiality: Once you sign the consent form, we will not require any personal identifiable information such as name, NSID, SIN etc. Submission of emails address will be optional - required only if you are interested in participating in future studies relating to this particular project. Your email will not be used for any purpose beyond this project

Dissemination of Results: Aggregated results derived from this study will appear in a PhD thesis and articles published in peer reviewed conferences and scientific journals. However, any information that can be linked to a specific participant will be removed or altered and any quotations from participants that are published will be so only if no linkage can reasonably be made to the participant in any way.

Right to Withdraw: Your participation in this study is voluntary, and you may withdraw from the study for any reason, at any time, without penalty of any sort, however, you will not receive the compensation for participation. If you withdraw from the study at any time, any data that you have contributed will be deleted.

Questions: If you have any questions concerning the survey, please feel free to ask at any point; you are also free to contact the researchers at the numbers provided above or via email (regan@cs.usask.ca, jiv@cs.usask.ca, rita.orji@usask.ca). This Survey has been approved on ethical grounds by the University of Saskatchewan Behavioural Research Ethics Board. Any questions regarding your rights as a participant may be addressed to that committee through the Ethics Office (966-2084).

Follow-Up or Debriefing: If you would like to know the results of this study, you can contact the researchers

Consent to Participate: I have read and understood the description provided; I have had an opportunity to ask questions and my questions have been answered. I consent to participate in the Survey, understanding that I may withdraw my consent any time during the study. A copy of this Consent Form has been given to me for my records.

○ I consent ○ I don't consent