JYVÄSKYLÄ STUDIES IN COMPUTING
260

Tuomas Kari

Exergaming Usage: Hedonic and Utilitarian Aspects

JYVÄSKYLÄN YLIOPISTO

JYVÄSKYLÄ STUDIES IN COMPUTING 260

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Esitetään Jyväskylän yliopiston informaatioteknologian tiedekunnan suostumuksella
julkisesti tarkastettavaksi yliopiston Agora-rakennuksen Lea Pulkkisen salissa
helmikuun 11. päivänä 2017 kello 12.

Academic dissertation to be publicly discussed, by permission of
the Faculty of Information Technology of the University of Jyväskylä,
in building Agora, Lea Pulkkinen hall, on February 11, 2017 at 12 o'clock noon.

UNIVERSITY OF JYVÄSKYLÄ

JYVÄSKYLÄ 2017

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Publishing Unit, University Library of Jyväskylä

Cover picture by Ilari Nummi.

Permanent link to this publication: http://urn.fi/URN:ISBN:978-951-39-6956-1

URN:ISBN:978-951-39-6956-1
ISBN 978-951-39-6956-1 (PDF)

ISBN 978-951-39-6955-4 (nid.)
ISSN 1456-5390

Jyväskylä University Printing House, Jyväskylä 2017

"In order for man to succeed in life, God provided him with two means, education and physical activity. Not separately, one for the soul and the other for the body, but for the two together. With these means, man can attain perfection."

(Plato, circa 386 BCE)

ABSTRACT

Kari, Tuomas
Exergaming Usage: Hedonic and Utilitarian Aspects
Jyväskylä: University of Jyväskylä, 2017, 87 p. (+ included articles)
(Jyväskylä Studies in Computing
ISSN 1456-5390; 260)
ISBN 978-951-39-6955-4 (nid.)
ISBN 978-951-39-6956-1 (PDF)

There is a growing demand for information systems (IS) that could advance desirable health behaviours among people. While digital gaming has generally been perceived to increase individuals' sedentary time, gaming can also act as a medium to promote health, for example, by increasing individuals' levels of physical activity. Exergaming, a form of digital gaming that combines games with physical activity, has been mentioned as potential means of influencing physical activity levels. Previous research on exergaming has been dominated by a very device-centric perspective, focusing more on its technological and physical aspects, than a more user-centric perspective that focuses on the users and the different aspects of usage. Such user-centric focus is greatly needed to achieve the recognised yet unreached potential of exergames, for example, to enhance the population's levels of physical activity. The importance of researching IS usage has been continuously stressed in the field of IS, and increasing the understanding of IS use is important for both scholars and practitioners alike. Considering the identified research gap and the importance of the topic, this thesis takes a user-centric approach with aim to explain relevant aspects throughout the entire use cycle of exergames: intention to use, adoption and usage habits – as well as the reasons for not using – and use continuance after exergaming experiences. This thesis also examines the ability of exergames to promote physical activity and physical fitness. To investigate these aspects, relevant studies are carried out using both quantitative and qualitative research methods. This thesis demonstrates the perceptions of exergames and how they differ in different phases of the use cycle. The results highlight the importance of hedonic enjoyment perceptions behind usage intentions and the actual use of exergames; however, for the continued use of exergames, the perceptions of utilitarian benefit also have an important role. The theoretical contribution comes from providing valuable new knowledge to the scientific community and increasing the theoretical understanding of exergaming. The findings also pose several practical implications for different stakeholders, ranging from the developers and marketers of exergames to the public sector and the users.

Keywords: exergames, exergaming, usage intentions, user behaviour, habits of playing, user experience, use continuance, information systems usage

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ACKNOWLEDGEMENTS

Contained within these pages is the outcome of a project that has been an immense part of my life for the past few years. This project has been interesting in a myriad of ways. I have learned a lot, not least how much more there is to learn. But, I believe I understand this topic sufficiently to state so here. The project has been one amazing race during which I have got to meet many fascinating people and visit some of the most picturesque of places. This journey is now finished, but before venturing forth to the challenges ahead, there are a number of people to whom I would like to present my gratitude.

Lauri Frank, my principal supervisor, thank you for providing me with a job in the Sedospo and Biogame projects. Thank you for your guidance, ideas, and discussions reaching far beyond than just the scope of my dissertation. I have always felt that you have trusted me and given me the freedom to follow my own compass. Moreover, I thank you for showing me the way when I was unsure which path to follow.

Taija Juutinen, my co-supervisor, thank you for providing me with support and guidance from the sports science aspects when I needed it.

Besides my supervisors, I express my sincere appreciation and gratitude to the pre-examiners of my dissertation, Associate Professor Marina Papastergiou and Professor Harri Oinas-Kukkonen, and especially to the Opponent of the dissertation, Professor Christer Carlsson, for their insightful and assuring statements.

I am thankful to the Foundation for Economic Education (Liikesivistysrahasto) as well as Jenny and Antti Wihuri Foundation for the research grants to support my thesis.

I would also like to express my appreciation for all the wonderful colleagues I have been fortunate to work with. Panu Moilanen, the man whose mission is to know. For recruiting me to first do my master’s thesis and then start my dissertation with the Sedospo-project back in the day. I have always trusted on your advice. Markus Makkonen, for co-authoring articles and the help with all the statistics software. Your skills still amaze me. I am looking forward to continue working with you. Markus Salo, for co-authoring articles and for our interesting discussions. Tuure Tuunanen, for reading through my work, providing advice, and encouragement.

I am thankful for the very multicultural work environment in which I have been privileged to work at. People from Finland, Russia, England, Germany, Hungary, Spain, Macedonia, Greece, Turkey, Egypt, Iran, India, China, Hong Kong, South-Korea, Australia, Cameroon, Gambia, and where else. There’s probably been someone from Antarctica as well. Mikko Siponen, Arto Ojala, Eetu Luoma, Andy Zhang, Alain Tambe Ebot, Eeva Kettunen, Hadi Ghanbari, Henri Pirkkalainen, Johanna Silvennoinen, Jose Cañas Bajo, Juuli Lintula, Kati Clements, Manja Nikolovska, Naomi Woods, Philipp Holtkamp, Piia Perälä, Tiina Koskelainen, Tapio Tammi (especially for all the coconut recipes), and the other coffee room folks from the Department of Computer Science and

Information Systems. It has been most interesting to discuss with you about research, different cultures, and a little bit of this and that. I also would like to thank Sami Kollanus for all the help and practical arrangements throughout the dissertation project. And, of course, Seija Paananen, our former department secretary. No matter how dark the sky outside, you always were the sunshine in the department, first thing in the morning.

Furthermore, I would like to thank those other scholars from around the world with whom I've had the pleasure to meet and talk about my research with. I especially would like to acknowledge Ann DeSmet, for hosting me during my visit at the Ghent University, and David Gefen, for your wise words, not just about research but also the life around it. I remember our adventures with warmth.

Certainly, I owe an enormous gratitude to my family – parents and little sister. Although I am sure you do not understand a thing about what I do, your support has been invaluable. My orienteering family, Angelniemen Ankkuri and all the others – I promise to be more social in the future. A thank you goes out to one Maco as well for putting up with me all these years.

Finally, my warmest gratitude goes to my wife Jaana. For so many things that I don't even know where to begin with. Thank you for understanding, being there for me through those times when I was struggling. Thank you for reading my work, all the feedback, teaching me when one can speak about effect or especially when not, for the countless statistical advices, and the great many discussions (even the ones I didn't like) – looking forward to the many more to come. I am fortunate to have you by my side and reminding me what is truly important in life.

Here's looking at you kid.

Jyväskylä 31.12.2016
Tuomas Kari

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II. Kari, T. 2015. Explaining the Adoption and Habits of Playing Exergames: The Role of Physical Activity Background and Digital Gaming Frequency. In Proceedings of the 21st Americas Conference on Information Systems (AMCIS) 2015.

III. Kari, T. 2014. Can Exergaming Promote Physical Fitness and Physical Activity?: A Systematic Review of Systematic Reviews. International Journal of Gaming and Computer-Mediated Simulations, 6(4), 59-77.

IV. Kari, T. & Makkonen, M. 2014. Explaining the Usage Intentions of Exergames. In Proceedings of the 35th International Conference on Information Systems (ICIS) 2014.

V. Kari, T., Makkonen, M., Moilanen, P. & Frank, L. 2013. The Habits of Playing and the Reasons for Not Playing Exergames: Age Differences in Finland. International Journal on WWW/Internet, 11(1), 30-42.

VI. Kari, T., Makkonen, M., Moilanen, P. & Frank, L. 2012. The Habits of Playing and the Reasons for Not Playing Exergames: Gender Differences in Finland. In U. Lechner, D. Wigand, & A. Pucihar (Eds.), Proceedings of the 25th Bled eConference 'eDependability: Reliable and Trustworthy eStructures, eProcesses, eOperations and eServices for the Future', 512-526.

VII. Makkonen, M., Frank, L., Kari, T. & Moilanen, P. 2012. Explaining the Usage Intentions of Exercise Monitoring Devices: The Usage of Heart Rate Monitors in Finland. In Proceedings of the 18th Americas Conference on Information Systems (AMCIS) 2012.

The articles are presented here in reverse chronological order (latest one first), i.e. Article I is the newest and Article VII the oldest in terms of time of publication. The first author did the majority of the work in each article. For Article I, the co-authors assisted with overall guidance and previous insights on the subject. For Article IV, the co-author conducted the statistical analysis and reported the methodology. For Articles V and VI, the co-authors provided overall guidance and assisted in data collection. For Article VII, the co-authors assisted with planning, overall guidance, and in data collection.

1 INTRODUCTION

The rapid advancement of information technology (IT) has influenced various information systems (IS) areas and facilitated the development of entirely new types of innovations, many of which can be used for both utilitarian and hedonic reasons. These have provided industries and people around the globe with huge benefits and changed the work and leisure-time in many ways. These changes in work and society have led to a significant decrease in occupational physical activity, which has been replaced with physical inactivity (Hallal et al., 2012). Even though some of this decrease has been replaced by increased leisure-time physical activity among adults (Hallal et al., 2012), the popularity of leisure-time sedentary activities brought by new media solutions such as television viewing, computer use, and video gaming has also increased remarkably (Matthews et al., 2008; Matthews et al., 2012). As the health detriments of physical inactivity and the health benefits of physical activity are well-established (e.g. Lee et al., 2012; Warburton et al., 2006; WHO, 2010), there is certainly a demand for IT and IS that could advance desirable health behaviours and a need for related research respectively. While digital gaming has generally been perceived to increase individuals'sedentary time, gaming can also act as a medium to promote health (Nah et al., 2014) and be used as a tool for health and physical activity education (Papastergiou, 2009) as well as in many other health-related domains (Kiili et al., 2013). Exergames, in particular, have been proposed as a possible catalyst for increasing physical activity (e.g. Krause & Benavidez, 2014; Papastergiou, 2009) and replacing sedentary behaviours (Kari, 2014).

The importance of researching IS usage and IS use behaviours has been continuously stressed in the field of IS. Increasing the understanding of IS use is essential for both scholars and practitioners alike (Straub & Del Giudice, 2012). However, according to Grover and Lyytinen (2015), most studies aiming to produce IS knowledge have followed approaches restricted to a rather general or abstract level, and there is a need for more specific knowledge to continue the development of the IS field. Thus, IS scholars are called to develop and advance contextual theories and focus on more context-specific approaches (Grover & Lyytinen 2015; Venkatesh et al., 2012).

This thesis specifically focuses on the context of exergames and its different usage aspects. This context-specificity offers opportunities to gain a deeper understanding of the user behaviours within this specific context, which is considered valuable for both theory and practice (Burton-Jones & Straub, 2006; Venkatesh et al., 2012). This thesis also sheds light on the utilitarian and hedonic motivations of system use, which deserve a more prominent place in IS research (Lowry et al., 2013; Wu & Lu, 2013).

The aim of this thesis is to explain relevant aspects throughout the entire use cycle of exergames: intention to use, adoption and usage habits – as well as the reasons for not using – and use continuance after critical exergaming experiences. The ability of exergames to promote physical activity and physical fitness is also investigated. The central claim of the thesis is that hedonic perceptions are more important than utilitarian perceptions in exergames usage.

1.1 Background and research environment

During the past decades, developments in information and communication technology (ICT) have had a significant impact on a number of fields related to IS. One such field is video gaming, where the emergence of new sensor and other technologies has facilitated the design and development of entirely new gaming concepts and resulted in video gaming becoming one of the most popular entertainment mediums in the world (Maddison et al., 2013). Market research firm Newzoo (2015) estimated that the worldwide market for video games will increase from US$83.6 billion in 2014 and US$91.5 billion in 2015 (estimate) to US$113.3 billion by 2018. Another rapidly advanced field is that of sports and wellness technology. The usage of different kinds of ICT based devices and services to support physical activity has become a part of everyday life for an increasing amount of people. Heart rate monitors (HRMs) are common training partners for many physically active people. Sports and wellness technology covers different kinds of applications related to physical activity, training, and exercise that play an assistive role for those interested in wellbeing and physical fitness. These technologies enable self-tracking of different measures (Kari et al., 2016a; 2016b). Although the possibilities of sports and wellness technology are many, it is important to keep in mind that they are first and foremost a factor to support physical activity, and do not replace it. While sports technology acts as a facilitator for development, the motivation and exercise itself are critical for the user (Malkinson, 2009). Nevertheless, the popularity of different sports and wellness technologies implies that on a general level, people are by no means afraid to use technology along with their physical activity. Additionally, implementing different game elements, i.e. the "*process of gamification*" (Kari et al., 2016c, 395), has become increasingly common in the context of health and exercise. Different gamification strategies can be executed through novel or existing games (Alahäivälä & Oinas-Kukkonen, 2016).

One example of combining sports technology and video games is digital exercise games, otherwise known as exergames. Exergaming is a form of video gaming that combines video gaming and physical activity to create a game that requires physical effort from the player to play the game. This type of gaming has also been referred to as active video gaming or exertainment, but exergaming seems to be the most widely adopted term (Oh & Yang, 2010). In the end, they all mean the same thing: games that combine physical activity and games by requiring the player to do some sort of physical activity to play the game. Müeller et al. (2011) defined exergames as digital games in which the outcome of the game is predominantly determined by physical effort. I propose a more comprehensive definition of exergaming: *A form of digital gaming requiring physical effort – exceeding sedentary activity level and including strength-, balance-, or flexibility-related activities – from the player that determines the outcome of the game*.

Exergames were originally designed and developed as an entertainment medium; however, later on, members of public health institutions and exergame developers themselves saw their utilitarian potential to increase physical activity by providing new ways for people to be physically active. This resulted in the development and sale of exergames not only for profit but also as a means to improve health. The general allure of digital technologies is that they are readily distributable and have the realistic potential to reach large populations. The added appeal and widespread familiarity of video gaming raises the potential of exergaming to promote a healthier lifestyle (Maddison et al., 2013).

Currently, there are an increasing number of exergaming options. The three most popular video gaming console lines, namely Sony's PlayStation, Nintendo's Wii, and Microsoft's Xbox, all offer devices and games that make exergaming possible in home settings. Additionally, there are numerous portable devices with different types of sensors, such as portable consoles, mobile phones, and tablets, which provide possibilities for exergaming in different kinds of settings. Other types of exergames exist, in addition to the aforementioned console-based and mobile-based exergames, such as those available in arcades or embedded into exercise equipment; however, the commercially available console-based and mobile-based exergames are the ones that are typically most accessible to the users (Chamberlin & Maloney, 2013).

Exergaming has the potential to provide both fun and utility for its users; thus, exergames can be used for either utilitarian or hedonic reasons (Osorio et al., 2012) or for both simultaneously (Berkovsky et al., 2010). The reasons for playing the games may therefore relate to such aspects as entertainment, socialising with other people or promoting one's social health, well-being, and performance.

Previous research has revealed that the usage of sports and wellness technologies can promote the motivation towards exercise (e.g. Ahtinen et al., 2008; Bravata et al., 2007). Prior research (e.g. Berkovsky et al., 2010) also suggests that exercise and games can be combined without adverse effects on the overall experience and enjoyment of playing, thus demonstrating the potential of exergames to motivate people to do more exercise or be physically more active. Accordingly, exergames can be seen as behaviour change support systems (BCSS), which are defined as "*socio-technical information system[s] with psychological and behavioral outcomes designed to form, alter or reinforce attitudes, behaviors or an act of complying without using coercion or deception*" (Oinas-Kukkonen, 2013, 1225).

As the popularity of exergames has grown among consumers and healthcare, exergames have also gained increasing attention among academic researchers. However, several important issues related to the user-centric perspective of exergaming remain less studied and vaguely understood. Previous research on exergames has mostly focused on the physical fitness aspect of these games or on their potential to promote physical activity. However, the ways such technologies are used, the motives for using them, and the effects they have on people's exercise and health behaviour are relatively unknown. Overall, research on exergaming has been dominated by a very device-centric perspective focusing on the games and gaming devices themselves and their physical aspects instead of a more user-centric perspective focusing on the users, user behaviour, and issues such as why users actually play (or do not play) these games. This is a severe shortcoming, as the understanding of these latter issues is crucial for developers and marketers of exergames in terms of offering users the kinds of games that meet their demands and thereby advancing their adoption and diffusion. It is also essential for several other stakeholders, such as the health and well-being industry and the society, in terms of finding new ways to motivate people to engage in more physical activity and tackle the problems of sedentary lifestyle, which are becoming increasingly prevalent in our present society and are thus becoming a global burden. Thus, a user-centric focus is needed to fulfil the recognised yet unreached potential of exergames to enhance people's levels of physical activity.

1.2 Objectives and scope

Considering the identified research gap and the importance of the topic, this thesis aims to provide a wide-range view of exergaming for the entire use cycle of exergames, including their use and acceptance and the possibility of using exergames to promote physical activity. The main focus is on the user-centric perspective: the users, user behaviours, and the usage of these games. Thus, the level of analysis is on the individual level, rather than the organisational level, and on games that are available to individual consumers. This research answers the following research questions (RQs):

- RQ 1: What kinds of factors explain the intention to use exergames as part of one's physical activity? (*Article IV*)
    - Difference to more traditional sports technology (comparing *Articles IV and VII*)

- RQ 2: How are exergames adopted and what are the usage habits of exergames? Are there differences between demographic backgrounds?
    - Gender (*Article VI*)
    - Age (*Article V*)
    - Physical activity and gaming background (*Article II*)
- RQ 3: What are the main reasons for not playing exergames? Are there differences between age and gender? (*Articles V and VI*)
- RQ 4: How is the role of situational context in post-experience use continuance of exergaming? (*Article I*)
- RQ 5: Can exergaming promote physical fitness and physical activity? (*Article III*)

To answer these questions, this thesis draws on the contents of different studies that were carried out (Articles I–VII). Figure 1 depicts the scope of the research and illustrates how the RQs and articles are interconnected. Together, the articles answer the investigated RQs and form the complete thesis. The articles are numbered in reverse chronological order (the latest one first), i.e. Article I is the newest and Article VII the oldest based on time of publication.

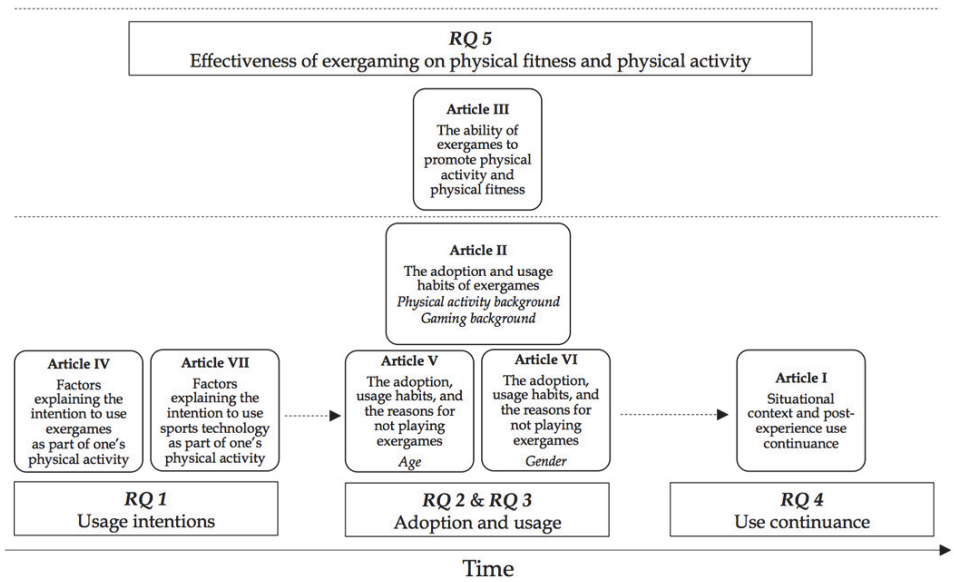

FIGURE 1 Scope of the research: Conceptualising exergame usage in the thesis

RQ 1 and Articles IV and VII. To date, research on exergaming has been dominated by a very device-centric perspective focusing on the games and their physical aspects, rather than a user-centric perspective that focuses on the users, user behaviour, and issues such as why users actually play the games. This is a significant shortcoming because understanding these reasons is considered a critical prerequisite for the analytical promotion of their adoption and diffusion with appropriate design and marketing decisions. To fill the aforementioned research gap concerning users and user behaviour in the context of exergaming, Article IV investigates what kinds of factors explain users' intentions to use exergames as part of their exercise. Similarly, Article VII investigates the same factors with one of the most common types of sports technology: HRMs. Thus, the factors that explain the intention to use exergames and more traditional sports technologies as part of one's physical activity are compared.

RQ 2 and Articles II, V, and VI. Concerning video game participation and gaming habits, prior research has mostly focused on gaming at a general level, while neglecting to establish who the exergame players actually are and what are the habits of playing. The innovation diffusion theory (IDT) (Rogers, 2003) classifies adopters of an innovation into five different adopter categories: innovators, early adopters, early majority, late majority, and laggards. Examining individuals in an adopter category in more depth often reveals some common traits and qualities. The IDT classifies these traits into three categories: socioeconomic characteristics, personality variables, and communication behaviour. From the socioeconomic category, the adoption rates of exergames are examined using two basic variables: age and gender in Articles V and VI. As exergames combine both exercise and gaming concepts, it is important to recognise whether and how the physical activity or gaming background is associated with the adoption and usage of these types of games. Thus, from the personality variables, Article II examines the adoption rates based on physical activity and gaming backgrounds. Articles II, V, and VII also investigate the usage habits of exergames and the different backgrounds associated with these usage habits.

RQ 3 and Articles V and VI. RQ 3 focuses on the reasons for not playing exergames, concentrating particularly on the gender and age differences, which similar to RQ 2, exergaming specific research has overlooked. These are important issues to explore, because the findings have important implications for the game designers and marketers to develop better games that could perhaps reach those who have not (yet) adopted these games.

RQ 4 and Article I. Researchers have highlighted the potential of exergames to provide health benefits for their users, revenues for the providers, and wellbeing for societies. However, their potential remains unreached because users of exergames tend to discontinue or diminish use after their initial experiences (Barnett et al., 2011; Peng et al., 2013; Maloney et al., 2015). Such use continuance and discontinuance of IS are influenced by users' single-use experiences (Cenfetelli, 2004; Serenko, 2006; Salo & Frank, 2015). Some single-use experiences are more influential than others; for example, exceptionally influential single-use experiences, which a person perceives or remembers as unusually positive or negative, are defined as critical incidents (Edvardsson & Roos, 2001). One central aspect that differentiates critical incidents is the situational use context. Prior studies have shown that situational context can be important for IS use continuance (Liang & Yeh, 2011; Salo & Frank, 2015; Venkatesh et al., 2011) or other user behaviours (e.g. Hong & Tam, 2006; Liu & Li, 2011; Mallat et al., 2009; Van der Heijden et al., 2005; Wang & Yi, 2012; Yang et al., 2012). However, in most of the previous studies, situational context has been treated as only one abstract construct, thus leaving a gap in IS research regarding the relationships between specific situational characteristics and use continuance. In addition, to the author's knowledge, a much wider gap in exergaming research exists because the relationship between situational context and use continuance has not previously been addressed. With exergames in particular, a more specific focus on use continuance and situational context is beneficial for the following reasons: (1) While several studies (e.g. Barnett et al., 2011; Maloney et al., 2015; Peng et al., 2013) have reported a decrease in exergaming play over time or during interventions, they have failed to provide an apparent reasons for this, (2) users' reactions to exergames in relation to other IS products are worth exploring because exergames can be used for either utilitarian or hedonic reasons (Osorio et al., 2012) or for both simultaneously (Berkovsky et al., 2010). Considering the dual-purposed and ubiquitous nature (Hong & Tam, 2006) of exergames and the fact that their use can take place in several different situational contexts, the role of context is highly important when it comes to exergames. Given this research gap and its importance, Article I investigates use continuance after critical exergaming incidents and the role of situational context.

RQ 5 and Article III. Over the past years, researchers have become increasingly interested in exergaming, particularly in its effects on physical fitness and physical activity levels. Article III conducts a systematic review of systematic reviews and meta-analyses of exergaming published in the fields of IS and healthcare to form a wide-range view of the effects that exergaming activities have on physical fitness and physical activity levels. More precisely, Article III investigates the levels of exertion that are typical for exergaming and examines whether exergaming can contribute to increasing physical activity levels and be used to increase physical fitness.

This thesis comprises five main sections. Following this introduction section, Section 2 presents the theoretical background of the thesis, and Section 3 discusses the research approach and methodology. Section 4 presents the results of each research article. Section 5 discusses the results and presents the theoretical and practical implications as well as the limitations and potential paths for future research. The original research articles are attached as appendices.

2 THEORETICAL FOUNDATION

This section presents the theoretical foundation and the studies relevant to the background of this thesis. Specific sub-sections discuss IS adoption and usage, physical activity, exergaming, research on exergaming, and the central aspects of the research. Finally, a summary of theoretical foundation is presented.

2.1 Information systems adoption and usage

IS adoption and usage, and various related aspects, have been extensively researched during the years. However, as the nature of IS is constantly changing (Petter et al., 2012), there is a growing demand for IS research to evolve in line with its changing nature. Several established theories and models exist in relation to IS adoption (e.g. Rogers, 2003), acceptance (e.g. Davis, 1989), use (e.g. Venkatesh et al., 2003, Venkatesh et al., 2012), use continuance (e.g. Bhattacherjee, 2001), and success (e.g. Delone & McLean, 1992). These theories are intended to explain the acceptance and use of technology on a general level, and they have been widely utilised in IS research. However, according to Grover and Lyytinen (2015), most studies aiming to produce IS knowledge have followed approaches restricted to a rather general or abstract level, and there is a need for more specific knowledge to continue the development of the IS field. Hence, to gain a deeper understanding of these highly important aspects of IS, researchers have been called to develop and advance contextual theories and focus on more context-specific approaches (Grover & Lyytinen, 2015; Venkatesh et al., 2012). While valuable efforts have been made in this direction (e.g. van der Heijden, 2004), the dominant stream of research on aspects related to IS usage has remained on a more general level.

This thesis investigates the aforementioned important aspects of IS in the specific context of exergaming. This contrasts with more generic and abstract IS studies, where the focus has been on a more general level. This context-specificity offers opportunities to gain a deeper understanding of the user behaviours within this specific context, which is considered valuable for both theory and practice (Burton-Jones & Straub, 2006; Venkatesh et al., 2012). Additionally, "*theories that focus on a specific context and identify relevant predictors and mechanisms are considered to be vital in providing a rich understanding of a focal phenomenon and to meaningfully extend theories*" (Venkatesh et al., 2012, 158).

2.2 Physical activity

Physical activity is defined by the WHO (2010) as any bodily movement produced by skeletal muscles that requires energy expenditure. Exercise is a subcategory of physical activity involving a purposeful set of activities, usually planned and structured, with the objective of improving or maintaining one or more components of physical fitness (WHO, 2010). The advancement of IT has brought huge benefits for industries and people around the globe, and it has changed people's work and leisure-time in many ways. These changes in work and society have led to a significant decrease in occupational physical activity levels during the past decades (Hallal et al., 2012). Even though some of this decrease has been replaced by increased leisure-time physical activity among adults (Hallal et al., 2012), the popularity of leisure-time sedentary activities brought by new media solutions such as television viewing, computer use, and video gaming has also increased remarkably (Matthews et al., 2008; Matthews et al., 2012). Sedentary activities are those where the required energy expenditure is very low and the dominant posture is sitting or lying (Pate et al., 2008). Researchers associate a sedentary lifestyle with several severe health risks among adults (e.g. Matthews et al., 2012; Thorp et al., 2011) and children (e.g. Saunders et al, 2014; Tremblay et al., 2011).

High levels of screen time contribute to a sedentary lifestyle especially among adolescents. An extensive study by Tremblay et al. (2014) involving 105 countries around the world suggested that only 20% of 13–15 year olds get sufficient daily physical activity to meet the WHO's (2010) physical activity recommendations for health; 5–17 years old should accumulate at least 60 minutes of moderate-to-vigorous intensity physical activity daily. As such, there is widespread evidence of a childhood physical inactivity crisis (Tremblay et al., 2014). The case is similar in Finland, where most of the youth have too much daily screen time and sedentary time (Liukkonen et al., 2014). Sedentary lifestyles have also affected people's physical fitness levels, and aerobic fitness levels have decreased during the last decades globally (Tomkinson & Olds, 2007). This holds true also for Finland, as an extensive population study by Santtila et al. (2006) reported a significant deterioration in physical fitness levels of Finnish men.

The health detriments of physical inactivity as well as the health benefits of physical activity are well established (e.g. Lee et al., 2012; Warburton et al., 2006; WHO, 2010). Physical activity has a positive impact on people's health and well-being, while physical inactivity is a serious public health issue that is a major risk factor for chronic diseases, such as cardiovascular disease and type 2 diabetes, which are the biggest single causes of death in Western countries (WHO, 2009). Several studies have also presented evidence on the increasing healthcare costs caused by physical inactivity (e.g. Ding et al., 2016; Kohl et al., 2012; Lee et al., 2012). Based on epidemiological studies, the WHO (2010) has given guidelines for the recommended amount of physical activity; for example, adults aged 18 years and above should do at least 150 minutes of moderate intensity aerobic physical activity throughout the week, or do at least 75 minutes of vigorous intensity aerobic physical activity throughout the week, or an equivalent combination of moderate- and vigorous intensity activity. However, too few people meet these guidelines.

Thus, physical inactivity is not only an individual problem but also a societal problem, and because of its importance from the perspectives of public health and finance, it is essential to find new ways to motivate people to be more physically active, do more exercise, and avoid physical inactivity.

2.3 Exergaming

Exergaming refers to a form of digital gaming that combines video gaming and physical activity by requiring physical effort from the player in order to play the game, and the outcome of the game is mainly determined by the user's physical efforts (Müeller et al., 2011). Exergaming can also be defined as experiential activity of playing video games that require physical exertion or movements that are more than sedentary activities and also include strength, balance, and flexibility activities (Oh & Yang, 2010). Following these conceptualisations, I propose a more comprehensive definition of exergaming: *A form of digital gaming requiring physical effort – exceeding sedentary activity level and including strength-, balance-, or flexibility-related activities – from the player that determines the outcome of the game*.

Today, there are a growing number of exergaming solutions. The three most widespread video gaming console lines, namely Microsoft's Xbox, Nintendo's Wii, and Sony's PlayStation, offer technology and games that enable exergaming in home settings. Moreover, a number of mobile devices, such as mobile phones, tablets, and portable consoles, enable exergaming in various different settings and utilise various sensors for playing. These different gaming platforms can be used, for example, in community (Baranowski et al., 2014) and public settings, such as medical centres, senior centres, fitness centres (Lieberman et al., 2011), and even in work and school environments (Maddison et al., 2013). In addition to console-based and mobile-based exergames, there are also other types of exergames, for example, those that are embedded into exercise apparatus' or are playable in arcades. Furthermore, some exergame systems can utilise (augmented) climbing walls (Kajastila & Hämäläinen, 2014), trampolines (Kajastila, Holsti & Hämäläinen, 2014), or similar solutions (Hämäläinen et al., 2015). Nevertheless, the commercially available console-based and mobile-based exergames are typically the ones most accessible to users (Chamberlin & Maloney, 2013). Console-based exergames can be characterised as games that are played in front of a TV set (also including virtual reality headsets), while mobile-based exergames are usually played outdoors in a much bigger playing area. A recent, very popular example of a mobile-based exergame is Pokémon GO. While consoles have been found to be the most popular platform on which to play exergames (Kari, 2015), the Pokémon GO boom is likely to prompt the emergence of other similar games to the market, thus raising the popularity of mobile-based exergames. Additionally, the various persuasive mobile applications to promote physical activity in general are also becoming increasingly widespread and popular (Matthews et al., 2016).

Exergaming has the potential to provide both fun and utility for the users. Therefore, exergames can be used for hedonic reasons, such as entertainment or fun, or for utilitarian reasons, such as exercise and promoting physical activity and health (Osorio et al., 2012), or for both simultaneously (Berkovsky et al., 2010). Hence, the reasons for playing exergames can relate to such aspects as enjoyment, entertainment, socialising with other people, or promoting one's well-being, physical health, and performance. This makes exergames an exemplar of dual-purposed IS, which deserve a more prominent place in IS research (Lowry et al., 2013; Wu & Lu, 2013). The ubiquitous nature (Hong & Tam, 2006) of exergames and the fact that they can be used in several different situational contexts make mobile exergames, in particular, a fine example of novel ubiquitous information systems, which have "*woven themselves into the very fabric of everyday life*" and have important implications for IS research (Vodanovich et al., 2010, 711)

Undoubtedly, some of the greatest benefits exergaming can provide are related to health (Maddison et al., 2013). The allure of video gaming and its widespread familiarity also adds to the potential of exergaming to promote a healthier lifestyle (Maddison et al., 2013). Exergames can offer additional advantages, such as promoting players' physical activity without requiring the players to have a deep understanding of physical exercise (Bogost, 2005). Exergames can also be designed for people of different ages – from children to elderly – as well as for people with different cognitive capabilities or physical abilities or disabilities, rehabilitation requirements, or other special needs. Similarly, exergames can be implemented with different coaching and assessment features, such as estimating the effects of playing on the physical condition of the players through heart rate or energy expenditure measures (Lieberman et al., 2011). Trout and Christie (2007) suggested that exergames could promote the motivation towards other forms of physical activity and may therefore act as a gateway or an incentive for a more active lifestyle. Vernadakis et al. (2015) found that exergames can be utilised to foster the development of fundamental motor skills (FSM) in children and suggested that implementing exergaming into their daily activities would likely assist children in achieving recommended levels of FSM and also influence their physical activity participation positively. Exergaming has also been suggested as possible means of increasing the physical activity levels of those whose screen time is high (Daley, 2009). In general, research suggests that exergames are alluring, motivational, and effective in providing health and fitness benefits (Papastergiou, 2009). Accordingly, exergames could be an efficient means of mitigating the growing obesity problem (Kiili & Merilampi, 2010).

Exergames have led to video gaming being viewed as a potential catalyst for increasing physical activity levels instead of just a sedentary activity that increases screen-time (Krause & Benavidez, 2014). Nevertheless, exergaming also poses some challenges. For example, prior studies (e.g. Lyons et al., 2011; Thin et al., 2013) have suggested that games requiring more vigorous physical activity might be perceived as less enjoyable than those requiring lighter physical activity. These reasons contribute to the need to conduct research on exergaming from a user-centric perspective.

2.4 Research on exergaming

In recent years, academic scholars have become increasingly interested in exergaming. The majority of existing studies focus on the physical fitness aspects of these games (e.g. Bethea et al., 2012; Howe et al., 2015; Larsen et al., 2013; Lyons et al., 2011; Maddison et al., 2007; Peng et al., 2011; Penko & Barkley, 2010; Scheer et al., 2014; Staiano & Calvert, 2011; Whitehead et al., 2010) or on their potential to promote physical activity (e.g. Adamo et al., 2010; Baranowski et al., 2012; Graves et al., 2010; Jenney et al., 2013; LeBlanc et al., 2013; Mhurchu et al., 2008; Peng et al., 2013; Rhodes et al., 2009; Trost et al., 2014; Warburton et al., 2007). However, the results of many of these studies have been rather mixed. For example, in terms of the potential of exergames to promote physical activity, some studies have found supporting evidence (e.g. Bethea et al., 2012; Trost et al., 2014), whereas others have found no such evidence (e.g. Adamo et al., 2010; Scheer et al., 2014) or the results have been inconclusive (e.g. Baranowski et al., 2014; Peng et al., 2013).

While the number of studies taking a user-centric perspective has increased recently (e.g. Adam & Senner, 2016; Gao et al., 2013; Hansen & Sanders, 2010; Hoda et al., 2013; Joronen et al., 2016; Limperos & Schmierbach, 2016; Lin et al., 2012; Lyons, 2015; Osorio et al., 2012), there is a dearth of understanding on the usage aspects of these games. In general, different studies have consistently stated exergaming to be fun and an enjoyable activity (e.g. Gao et al., 2013; Hansen & Sanders, 2010; Joronen et al., 2016). Hoda et al. (2013) found that exergames can help transform boring exercises into entertaining ones, which subsequently increases the player's motivation to continue exercising. Joronen et al. (2016) investigated the nonphysical effects of exergames through a systematic review and found exergaming to have some positive effects on self-concept, situational interest and motivation, enjoyment, psychological and social well-being, symptomatology and different learning experiences. Lin et al. (2012) found that perceived exercise utility and perceived enjoyment influence behavioural intention, but the intention is driven more by perceived enjoyment than perceived exercise utility. Lyons (2015) reported that challenge, feedback, and rewards may increase feelings of enjoyment during exergaming and are thus mechanism through which the enjoyment and subsequent engagement to exergaming can be improved. Osorio et al. (2012) found that the perceived exertion level while playing exergames, enjoyment perceptions, the social setting, and the players' feelings after the gaming session influence the use of exergames. Adam & Senner (2016) investigated long-term use of exergames and factors influencing long-term motivation. They found fun and affiliation to be the motives that increase likelihood for long-term exergaming motivation, whereas motives health, sports, weight loss, and competition do not seem to be correlated with it. Limperos & Schmierbach (2016) examined how player performance in an exergame affects psychological responses (autonomy, competence, and presence), enjoyment of the experience, and likelihood for continued future play of exergames. Their results suggest that individuals performing better experience greater presence and feel more autonomous, which then lead to greater enjoyment. Player performance/achievement also indirectly predicts continued future use via presence and enjoyment (positive) mediators.

Overall, a very device-centric perspective focusing on the games and gaming devices and their physical aspects has dominated the research on exergaming instead of a user-centric perspective focusing on the users, user behaviours, and issues such as why users actually play these games. This is a major shortcoming, because understanding issues related to users and their usage is essential, especially for exergame designers and marketers who strive to meet the requirements of users and consumers and subsequently advance the adoption and diffusion of exergames. Furthermore, it is important for numerous other stakeholders, such as the health and well-being industry and the society in general, for example, to find new methods for motivating people to engage in more physical activity and to tackle the prevalent and increasing problems of sedentary lifestyles in our present society.

2.5 Use cycle of exergames

This thesis aims to explain relevant aspects throughout the entire use cycle of exergames. Therefore, this thesis first investigates the factors that explain users' intention to use exergames and then examines how exergames are adopted, and explores the actual usage habits of exergames and the reasons for not using exergames. This thesis also investigates how critical exergaming experiences influence use continuance and the role of situational context in this. In addition, the ability of exergames to promote physical fitness and physical activity is also investigated. From a time-specific perspective, this potential of exergames is situated along with the actual use (see Figure 1).

2.5.1 Usage intention

Usage intention indicates the readiness to perform a certain behaviour. It is assumed to be an immediate antecedent of behaviour (Ajzen, 2002) and has been widely accepted as a good proxy variable for use (Liao et al., 2009).

To measure the intention to use exergames, theory of planned behavior (TPB) by Ajzen (1985; 1991) is used as the underlying theory. TPB is an extension of the theory of reasoned action (TRA) by Fishbein and Ajzen (1975; 1980) and is one of the most commonly used theories for explaining human behaviour. Previous IS research (e.g. Mathieson, 1991; Taylor & Todd, 1995) has shown that TPB provides a good understanding of the multifaceted associations within the antecedents of usage intention.

In accordance with TPB, it is hypothesised that the intention to use exergames would be explained by three factors: attitude towards their usage, subjective norm towards their usage, and perceived behavioural control over their usage (Figure 2). Here, attitude refers to an individual's positive or negative evaluations of performing a behaviour, subjective norm refers to an individual's perception of social pressure to perform or not perform the behaviour, and perceived behavioural control refers to an individual's sense of capability, control, and self-efficacy to perform the behaviour. Each of these three factors is hypothesised to have a positive effect on usage intention. That is, the more positive the attitude towards usage and the stronger the subjective norm towards the behaviour and the perceived behavioural control over the behaviour, the stronger should be the usage intention.

In addition to explaining usage intention with the three aforementioned factors, the aim is to also explain the attitude towards using exergames with carefully selected behavioural beliefs on the outcomes of usage, as most prior studies have found attitude to be the most important factor for explaining behavioural intention (Fishbein & Ajzen, 2010). Figure 2 presents a schematic illustration of TPB (the dashed lines indicate elements omitted from this study).

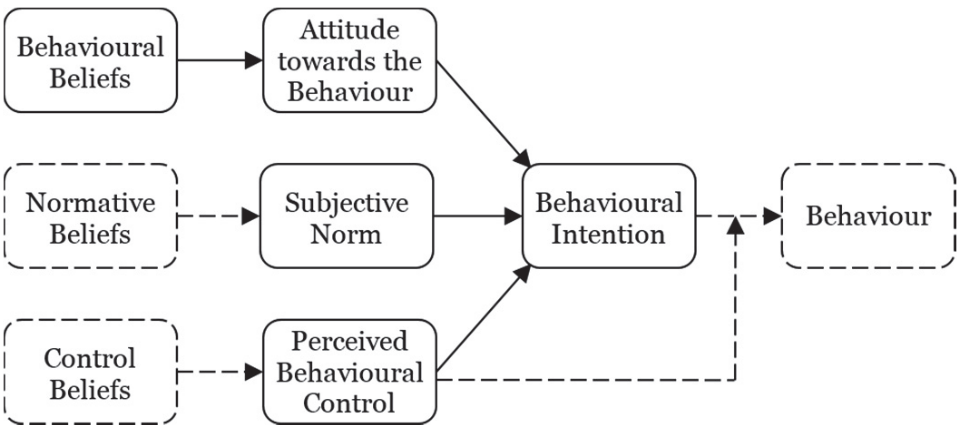

FIGURE 2 The theory of planned behavior (Ajzen, 1985; 1991)

2.5.2 Adoption

Regarding adoption, this thesis refers to the IDT by Rogers (2003). Because of the explorative nature of the investigation regarding the adoption of exergames, any *a priori* hypotheses on how different backgrounds are expected to be associated with the adoption of exergames (e.g. positively vs. negatively or linearly vs. non-linearly) are not proposed. However, the IDT, which is used as a theoretical argument for why these kinds of relationships are expected to exist, aims to explain how new products, services, and ideas spread in a social system. According to the IDT, the diffusion of an innovation is hypothesised to happen through a systematic process over time, which means that the time when an individual of a social system adopts an innovation is expected to vary. The main determinant for this is the so-called innovativeness of an individual, which is a persistent trait reflecting an individual's underlying nature when exposed to an innovation (Yi et al., 2006). This innovativeness can be further divided into global-specific innovativeness and domain-specific innovativeness (Goldsmith et al., 1995). Both these types of innovativeness are fundamentally hypothesised to have a similar effect: the more innovative an individual is, the earlier the individual is likely to adopt the innovation in question.

In examining the determinants of innovativeness, individuals are typically classified into adopter categories based on the relative time (earliness/lateness) that the individual adopts an innovation in the social system. In the IDT (Rogers, 2003), adopters are classified into five different adopter categories: innovators, early adopters, early majority, late majority, and laggards. When examining the individuals in an adopter category in more detail, some common traits and qualities typically emerge. The IDT classifies these traits into three categories: personality variables, socioeconomic characteristics, and communication behaviour.

This thesis examines the adoption rates of exergames using two basic variables from the socioeconomic category: age and gender. In addition, this thesis investigates the adoption rates based on physical activity and gaming backgrounds, which are considered personality variables.

2.5.3 Usage habits

In IS research, habit is often conceptualised as repeated behavioural sequences that are automatically triggered by environmental cues (Cheung & Limayem, 2005; Limayem et al., 2003) or "*the extent to which using a particular IS has become automatic in response to certain situations*" (Limayem et al., 2003, 2). In this thesis, the concept of habit refers, not to the repeated automatically triggered behaviours, but rather to the diverse *ways people use IS* and *how people use IS*, in this case exergames (e.g. the reason of playing, the frequency of playing, the physical exertion level of playing, and the setting of playing). Previous IS research has used similar conceptualisations of habits (e.g. Böhler & Schüz, 2004; Komulainen et al., 2008; Lehtinen et al., 2009).

Because of the lack of prior research on the usage habits of exergames, the investigation of usage habits in this thesis is explorative in nature, meaning that the habits of playing exergames are examined at a descriptive level without utilising any prior theoretical framework. This thesis refers to habit as the *ways (how) people use IS*.

In addition to investigating the associations of different backgrounds (age, gender, gaming, physical activity) on the adoption of exergames, this thesis more specifically focuses on how these backgrounds are associated with the usage habits of exergames.

2.5.4 Use continuance

Use continuance – or continued use – is, in its different forms, one the most widely recognised potential post-experience behaviours after a product or service experience (Holloway & Beatty, 2008; Meuter et al., 2000; Zeithaml et al., 1996; Zhou, 2011). In IS literature, use continuance typically refers to whether or not the user continues to use a particular IS product or service after its initial adoption (Bhattacherjee, 2001; Limayem et al, 2007). Continued use is usually considered a valuable behaviour from the vendor or service provider's viewpoint (Zeithaml et al., 1996), because it often directly influences the creation and maintenance of customer relationships. While continued use is deemed essential for the survival of many IS and IT services (Hong et al., 2006) and highly important in terms of IS success (Bhattacherjee, 2001; Limayem et al., 2007), discontinued use is considered an undesired behaviour (Zeithaml et al., 1996).

Despite the importance of studying IS use continuance, IS research has so far primarily focused on adoption and the initial phase of use (Bagayogo et al., 2014). Even though interest in this phenomenon has grown, previous research has not provided sufficient insight into the characteristics of post-adoptive IS use continuance (Bagayogo et al., 2014). In addition, the eventual success of an IS is less dependent on its initial adoption than its continued use (Bhattacherjee, 2001).

Previous research has identified different factors and aspects that influence IS use continuance, including satisfaction and perceived usefulness (Bhattacherjee, 2001), relationship commitment and trust (Vatanasombut et al., 2008), and behavioural attitude and perceived switching cost (Hong et al., 2008). One relevant yet under-researched aspect that has also proven to be important is the situational context (Liang & Yeh, 2011; Salo & Frank, 2015; Venkatesh et al., 2011). However, the research investigating the characteristics of the situational context and their influence on use continuance is limited. In this thesis, use continuance refers to both the intended and the actual post-experience behaviour.

2.6 Summary of the theoretical foundation

Most studies aiming to produce new knowledge on IS have followed rather general or abstract level approaches, and there is a need for more specific knowledge to continue the advancement of the IS field. Hence, to examine the various important aspects of IS in more depth, researchers are encouraged to focus on more context-specific approaches and develop contextual theories. This thesis therefore examines important aspects of IS in the specific context of exergaming.

During the past years, academic researchers have become increasingly interested in exergaming. However, the research has been dominated by a very device-centric perspective focusing more on its technological and physical aspects instead of a more user-centric perspective that focuses on the users and different aspects of usage. While the number of studies from a user-centric perspective has increased recently, an understanding of the users and the usage aspects of these games is limited. Such user-centric focus is therefore greatly needed to achieve the recognised yet unreached potential of exergames, for example, to enhance the population's levels of physical activity.

Therefore, this thesis takes a user-centric approach to explain relevant aspects throughout the entire use cycle of exergames: intention to use, adoption and usage habits – as well as the reasons for not using – and use continuance after critical exergaming experiences. In addition, the ability of exergames to promote physical activity and physical fitness is also examined. To investigate these aspects, relevant studies are carried out by using different research methods, presented in the following research methodology section. More extensive and in-depth theoretical backgrounds can be found in the relevant articles.

3 RESEARCH METHODOLOGY

This section presents the methodological approaches used in the articles of this thesis. First, the general approach and philosophical perspective are discussed, followed by the descriptions of the data collection and analysis.

3.1 Research approach

This thesis applies inductive and deductive research approaches. An *inductive approach* begins from the observations, and theories are developed as a result of observations towards the end of the research (Goddard & Melville, 2004). A *deductive approach* concerns developing a hypothesis based on existing theory, and then designing a research strategy to test the hypothesis (Wilson, 2014). The dichotomy between these two is, however, not unambiguous, as a certain amount of overlap can exist.

This thesis comprises exploratory and confirmatory studies, and some articles contain both exploratory and confirmatory elements. In *exploratory studies*, the aim is not to confirm relationships specified *a priori* to the analysis. Instead, exploratory approach allows the method and the data to define the nature of the relationships. The possible relationships are defined in a general form allowing multivariate techniques to estimate a relationship (Boudreau et al., 2001). Exploratory research is suitable for investigating what is happening, exploring a limitedly understood subject, or investigating a phenomenon in a new light (Saunders et al., 2009). The goal of exploratory research is to gain new insights (Jaeger & Halliday, 1998). Exploratory research follows the inductive research approach.

Confirmatory studies, conversely, seek to test and confirm pre-specified relationships (Boudreau et al., 2001). Confirmatory research begins with *a priori* hypotheses regarding the subject of interest, followed by the development and use of a research design that allows testing the hypotheses in question, data collection, data analysis, and researcher's inductive inferences (Jaeger & Halliday, 1998). Confirmatory studies follow the deductive research approach.

Article I follows mainly an inductive-deductive research approach. Articles II, V, and VI mainly follow the inductive research approach, as they are explorative in nature. Articles IV and VII contain both exploratory and confirmatory elements and follow the hypothetico-deductive research approach, with which a new theoretical model for explaining the usage intentions of exergames (Article IV) or HRMs (Article VII) is first proposed and then this model is empirically tested. Article III, a systematic review, mainly follows the inductive approach. Thus, the whole thesis follows different carefully selected approaches.

All research is based on some philosophical assumptions. The most relevant of which are those related to the underlying epistemology. Epistemology refers to the assumptions about knowledge and how it is to be obtained (Myers, 1997). Myers (1997) classifies epistemologies into three categories: positivist, interpretive, and critical, but adds that, even though these three categories are philosophically distinct, the distinction is not always as unambiguous in practice. The *positivist approach* typically assumes that reality is objectively given and can be described by measurable properties independent of the researcher and instruments. Positivist research thus aims to test theory to increase the predictive understanding of phenomena. The *interpretive approach* typically assumes that reality (given or socially constructed) can only be accessed through social constructions such as language, consciousness, and meanings that people assign to phenomena. Interpretive research does not have predefined independent and dependent variables, but instead focuses on the human sense making in certain situations. The *critical approach* generally assumes that social reality is constituted historically and is produced and reproduced by people. Critical research is seen as a social critique with the focus on the oppositions, conflicts, and contradictions in contemporary society (Myers, 1997). Keeping in mind the ambiguous distinction of these approaches, this thesis contains characteristics from two epistemologies: positivist and interpretive.

3.2 Data collection

The collection of empirical evidence took place during different periods between December 2011 and April 2015. The main data collection method was an online survey. In total, three different online surveys were conducted to gather the data sets: The first survey was administered between mid-December 2011 and the end of January 2012, the second one was conducted between mid-October and mid-December 2013, and the third one was administered between the beginning of February 2015 and end of April 2015. The first survey received 3,036 valid responses, the second received 1,091 valid responses, and the third received 1,151 valid responses. The first data set was used in Articles V, VI, and VII, the second in Articles II and IV, and the third one in Article I. The survey questionnaires included different sections, and comprised both open-ended and closed-ended multiple-choice questions concerning different research aspects. The items of the questionnaire sections used in each study can be found in the Appendices of each article. In addition to these surveys, in Article III, the data collection method was a systematic review, which was conducted in January 2014. In the following sub-sections, the use of different methods is presented on a general level. The articles contain more detailed descriptions of the use of each method in the studies and a discussion about the representativeness of the samples.

3.2.1 Survey

Survey research, in a broad sense, involves measurement practices that contain asking questions of respondents. The two broad types of surveys are questionnaires and interviews (Trochim, 2006). In this thesis, all surveys were the questionnaire type. Questionnaires are instruments that the respondent completes (Trochim, 2006). The surveys were conducted as electronic online surveys. The online survey method was selected for the data collection because of its effectiveness in gathering the large amount of quantitative data required for the studies. In general, the studies were conducted among Finnish consumers. Due to the delivery method of the surveys and ethical viewpoints, children were not reached with the surveys. Online surveys have the limitation of only being able to reach those who have Internet access. Also, certain populations are less likely to have Internet access and to respond to online questionnaires. However, as exergames are novel digital products, it can be expected that most, if not all, exergame users have access to Internet. Thus, it is probable that no target respondents were ruled out because of the possible lack of Internet access.

Regarding the first data set used in Articles V, VI, and VII, an online survey was administered to Finnish consumers. The survey was created using LimeSurvey 1.91+ software, and before launching it online, it was pre-tested qualitatively with two postgraduate students and quantitatively with 56 undergraduate students. The survey was online from mid-December 2011 to the end January 2012. During this time, the survey link was actively promoted by posting it to several Finnish discussion forums focusing on a variety of topics (e.g. sports, technology and gaming, parenting, seniors, agriculture, economy) and by sending several invitation e-mails through the internal communication channels of our university and an e-mail list provided by a Finnish company specialising in the testing of exercise devices. To raise the response rate, 26 gift cards with a total value of €750 were raffled among the respondents. The survey questionnaire consisted of several sections, and the total number of questionnaire items presented to each respondent varied from 46 to 130, depending on their responses.

Regarding the second data set used in Articles II and IV, an online survey was conducted among Finnish consumers. The survey was created using LimeSurvey 2.00+ software. Before the survey was launched, the questionnaire was pre-tested quantitatively with 87 undergraduate students and qualitatively with five IS and sports science researchers. Based on the received feedback, a few minor modifications were made to the wording and order of items. The final questionnaire was online for two months during October–December 2013. During this period, the survey was actively promoted by posting a survey link on several Finnish discussion forums focusing on a variety of topics, sending invitation emails through the communication channels of our university, and sharing the link in social media. To raise the response rate, the respondents who completed the survey were given the opportunity to take part in a drawing of six gift cards totalling €160. The survey questionnaire consisted of several sections, and the total number of questionnaire items presented to each respondent varied depending on their responses. Some of the sections and some of the items were conditional. For example, the data concerning the habits of playing exergames (Article II) and the data for testing the theoretical model (Article IV) were collected only from the players, i.e. respondents who stated to play exergames. This was to ensure that the respondents had at least some experience with the games and could give responses based on actual usage.

Regarding the third data set used in Article I, an online survey was conducted among Finnish consumers. The study design followed relevant guidelines for critical incident technique (CIT) studies presented by Gremler (2004). The questionnaire was iteratively designed with a qualitative pre-test phase and quantitative pilot phase that were run before the launch of the survey. During the pre-test phase, the questionnaire was discussed with five other scholars from the IS field. Based on the discussions and received comments, a few minor modifications were made. In the pilot phase, a pilot survey was administered to 70 respondents with additional space provided for their comments about the survey. Based on their responses, final improvements were made and the survey was launched. The survey was active from the beginning of February 2015 to the end of April 2015. The questionnaire was distributed to the respondents by posting a link on several Finnish discussion forums that focus on a variety of topics, sharing the link on social media, and sending invitation emails through different mailing lists. To motivate the respondents, those who completed the survey and submitted their email addresses were offered the opportunity to take part in a raffle of five gift cards with a total value of €130. The survey questionnaire consisted of several sections, and the total number of questionnaire items presented to each respondent varied depending on their responses. For example, only those respondents who had an experience of playing exergames were asked to report their critical incidents and related aspects. To collect the open-ended descriptions of critical incidents, the exact wording of several other prominent and widely cited CIT-related papers (e.g. Bitner et al., 1990; Johnston, 1995; Meuter et al., 2000) was used. Additionally, regarding use continuance, the intention construct was operationalised and measured using three statements adapted and modified from validated instruments presented in prior studies (Bhattacherjee, 2001; Mathieson, 1991; Serenko & Stach, 2009).

3.2.2 Critical incident technique

CIT was used in Article I to explore users' actual experiences (instead of hypothetical and general statements) and related use continuance. CIT has been extensively applied across a number of different disciplines (Butterfield et al., 2005), such as marketing, organisational psychology, and other business disciplines (Gogan et al., 2014). However, according to Gogan et al. (2014), CIT has been underused in the research published in the IS basket of 8 journals. Furthermore, CIT has not previously been applied in exergaming research. Gogan et al. (2014) stated that CIT is an excellent research method for IS researchers and a useful way to gain stronger study findings. Properly analysed critical-incident reports reveal valuable information concerning user behaviours in specific contexts (Andersson & Nilsson, 1964; Gogan et al., 2014).

A critical incident is defined as a single experience, which a person perceives or remembers as exceptionally positive or negative (Edvardsson & Roos, 2001). Researchers have presented arguments for the importance of studying critical incidents in terms of research and practice: Critical incidents are typically highly powerful and influential in terms of human behaviour (Flanagan, 1954). For example, a single crucially negative incident may overrule a set of ordinary positive incidents and lead to discontinued use of a service or a product (Cenfetelli, 2004). Critical incidents play a central role in forming customer relationships and user perceptions of products, services, and their providers (Edvardsson & Strandvik, 2000; Payne et al., 2008). Studying actual critical incidents, not just scenarios, enables researchers to achieve rigor and relevance (Serenko & Turel, 2010).

CIT is a well-established technique that involves a set of procedures (Flanagan, 1954) "*to collect, content analyse, and classify observations of human behaviour*" (Gremler, 2004, 66). CIT allows the respondents to describe the actual (positive or negative) incidents of IS use in their own words, and CIT questionnaires can include questions related to users' post-experience behaviours (cf. Meuter et al., 2000). CIT is also suitable for gaining insights and understanding about an undiscovered phenomenon (Gremler, 2004; Meuter et al., 2000), such as the role of the situational context related to use continuance after critical exergaming incidents. Thus, CIT is suitable for collecting actual experiences from exergame players and fits the purpose of this study. Other relevant advantages of CIT are that the respondents only report incidents of high relevance and importance, and critical incidents are easy to remember and describe. Thus, CIT can be used to generate an accurate and in-depth record of events (Grove & Fisk, 1997) that provides a rich set of data (Gabbott & Hogg, 1996). Naturally, CIT also has some limitations (Bitner et al., 1990; Gremler, 2004). First, it only collects extreme incidents instead of regular ones. Nevertheless, this approach is believed to be appropriate, since the users are thus able to report the specific situational characteristics in a more precise and plausible way. Second, as the incident has in many cases taken place at least some time before the collection of the data, there is a risk of recall and reinterpretation bias. To minimise this risk, the respondents were encouraged to calm themselves and take some time to recall the incident properly and then describe it in as much detail as possible. Overall, numerous studies (e.g. Andersson & Nilsson, 1964; Gremler, 2004) have demonstrated that CIT is a sound method providing both reliability and validity.

3.2.3 Systematic review

While a systematic review is often described in various ways between different fields of research, it always consists of several explicit and reproducible phases (Liberati et al., 2009). This thesis adopts the definition by Liberati et al. (2009): "*A systematic review attempts to collate all empirical evidence that fits pre-specified eligibility criteria to answer a specific research question. It uses explicit, systematic methods that are selected with a view to minimizing bias, thus providing reliable findings from which conclusions can be drawn and decisions made*" (Liberati et al., 2009, 2). Systematic reviews have become the standard approach in assessing and summarising applied health research (Shea et al., 2009). Thus, systematic review was chosen as the method to answer *can exergaming promote physical fitness and physical activity* instead of, for example, an intervention study.

A systematic review was used in Article III. To achieve scientific rigor, the methodology followed well-established guidelines given by Smith et al. (2011) and the PRISMA statement for reporting systematic reviews and meta-analyses (Liberati et al., 2009; Moher et al., 2009). The research design was determined *a priori*. The RQs, search strategy, and inclusion/exclusion criteria were established before the actual search and review, and the flow of information through the different phases of the systematic review was presented.

The search was conducted in a total of 10 databases using carefully selected keywords. The actual keywords used varied slightly between the different databases, depending on how the database handled search operators, but in every case, the keywords used aimed for maximal coverage of the studies under search. To ensure that no relevant articles were left unnoticed, the search was repeated after one month. In addition to the conducted database searches, the retrieved reviews were cross-referenced to find other potentially suitable systematic reviews and meta-analyses. After the search and initial screening, the inclusion and exclusion criteria were applied. In addition, the research design quality of the studies that met the criterion was assessed. To estimate the research design quality and risk of bias of the reviews, the AMSTAR tool (Shea et al., 2007; Shea et al., 2009) was used. AMSTAR is an 11-item instrument for evaluating the methodological quality of systematic reviews. AMSTAR was chosen because of its reliability (high interobserver agreement of the individual items with mean kappa=0.70) and construct validity (intraclass correlation coefficients=0.84) (Shea et al., 2009). The studies were rated as low, medium, or good quality. The same rating has been used in several previous studies (e.g. Fleming et al., 2014; Jaspers et al., 2011; Płaszewski & Bettany-Saltikov, 2014; Prior et al., 2008; Seo & Kim, 2012). Only reviews that were rated as good (≥9 AMSTAR score) were included. Studies that were rated as low quality (≤4 AM-

STAR score) or medium quality (5–8 AMSTAR score) were excluded. This was to ensure that possible false conclusions based on low quality research would be avoided (Shea et al., 2007). In addition, as Smith et al. (2011) point out, the strength of conclusions depends on the quality of included articles. Therefore, it was important to include articles of sufficient quality.

3.3 Analysis

This thesis uses both quantitative and qualitative analysis methods. Quantitative statistical analysis was used in Articles II, IV, and VII and partly in Articles I, V, and VI, while qualitative analysis was used in Article III and partly in Articles I, V, and VI. The following sub-sections present the use of different methods on a general level, and the articles provide more detailed descriptions of the use of each analysis method.

3.3.1 Quantitative analysis

A quantitative analysis approach was used in Articles II, IV, and VII and partly in Articles I, V, and VI. In Articles IV and VII, to find out what kinds of factors explain the intentions to use exergames (Article IV) and HRM (Article VII), the data was analysed using structural equation modelling (SEM) with the robust maximum likelihood (MLR) estimation. In addition to estimating the model, a careful evaluation of its goodness of fit as well as its validity and reliability at both construct and indicator levels was conducted. The analysis of the collected data was conducted using the IBM SPSS Statistics 19 (Article VII) and SPSS 21 (Article IV) and the Mplus 6 (Article VII) and Mplus 7.11 (Article IV) software. SPSS was mainly used for data preparation and a preliminary analysis, whereas Mplus was used for the actual SEM analysis. The operationalisation of the constructs was based on the general guidelines by Fishbein and Ajzen (2010) and validated instruments from previous literature (Davis, 1989; Karahanna et al., 2006; Ryan et al., 1997; Sweeney & Soutar, 2001; Taylor & Todd, 1995).

In Articles II, V, and VI, the quantitative statistical analysis was conducted using SPSS 19 (Articles V and VII) and SPSS 22 (Article II). The statistical significance and strength of the dependencies between the responses and the background factors (gender, age, or physical activity and gaming backgrounds) were analysed using contingency tables (crosstabs), the Pearson's χ^2 tests of independence, and the Cramér's V coefficients, with the level of significance set to $p \leq .050$. These methods enabled examination of both the linear and the non-linear dependencies, which suited the explorative nature of these studies. In Article II, there were few instances where the common condition for the validity of χ^2 test of "*No more than 20% of the expected counts are less than 5 and all individual expected counts are 1 or greater*" (Yates et al., 1999, 734) was not met. Thus, by following the widely used guidelines suggested by Cochran (1954) and Agresti (2002), the results of Pearson's χ^2 tests of independence were advanced using exact tests (Monte Carlo). The Monte Carlo (Mehta & Patel, 2012) test was based on 10,000 sampled tables and a 99 % confidence level. This procedure is considered reliable and independent of the dimension, distribution, allocation and balance of the analysed data (Mehta & Patel, 2012).

In Article I, to examine whether statistically significant relationships exists between situational characteristics and use continuance, the collected data were quantitatively analysed using SPSS 22. To analyse the significance of the differences between the situational characteristics and the post-experience *intended* use continuance, the mathematical means of the items for each construct were calculated and a t-test or analysis of variance (ANOVA) test was used. A t-test was used for variables with two nominal categories and ANOVA was used for variables with three or more nominal categories. Combined with the ANOVA test, either Tukey's HSD or Tamhane's T2 was used as post-hoc tests for pair comparisons. In some cases, the assumption of homogeneity of variance was not met, and in these cases, the Welch's F-ratio was analysed and reported. To analyse the differences between the situational characteristics and the post-experience *actual* use continuance, crosstabs was used. For 2x2 tables, Yates's continuity correction was examined, and for tables larger than 2x2, Pearson's χ^2 test was investigated. For all the performed tests, the level of significance was set to the $p \leq .050$ level.

3.3.2 Qualitative analysis

A qualitative analysis approach was used in Article III and partly in Articles I, V, and VI. In Article III, which was a systematic review, a qualitative analysis was used. After applying the inclusion and exclusion criteria and estimating the research quality, the included reviews were examined. This examination was done twice to authenticate the data extraction. Data extracted from each article included (a) methodological details, (b) key characteristics of the studies included in the reviews, (c) key findings pertaining to effects of exergaming on physical fitness and physical activity and perceptions of exergaming, (d) conclusions, (e) reported limitations, and (f) sources of funding. The data extracted from the included reviews were tabulated and summarised for further analysis. Because of the target of the systematic review (systematic reviews), the included articles possessed heterogeneity, and therefore, a meta-analysis (pooling of results) was not performed. Instead, a qualitative narrative synthesis was conducted. A narrative synthesis is an approach to a systematic review that synthesises findings from multiple studies based primarily on the use of text and words to summarise and explain the findings (Popay et al., 2006). A narrative synthesis allowed documenting the findings from the reviewed cross-disciplinary research in a suitable manner.

Article I had both quantitative and qualitative aspects as the collected critical incidents were first analysed using a quantitative statistical analysis and then using an additional qualitative content analysis following the CIT procedures (Gremler, 2004). To ensure the quality of the empirical evidence, guidelines from previous literature (Bitner et al., 1990; Gremler, 2004; Sweeney &

Lapp, 2004) were followed, and criteria for whether respondents' critical incidents should be included in the study were determined. Content analysis was used to establish the explanatory aspects of the quantitatively recognised relationships between situational characteristics and use continuance. The content analysis was conducted for the incident descriptions, which were obtained through open-ended questions. When doing this, the checklist for CIT content analytic studies by Gremler (2004) and guidelines for qualitative approaches by Sarker et al. (2012) were applied. The aim was to find recurring themes in the statistically significant relationships found in the statistical analyses. Thus, the focus was specifically on the characteristics of the incidents that were more likely to have led to positive or negative behaviours, instead of searching for the whole array and number of different explanations. The qualitative analysis process involved the following four main phases adapted from Gremler's (2004) guidelines:

1. The authors read and reread the incident descriptions to recognise common and explanatory tendencies for the statistically significant relationships. The findings were discussed between the authors and with other scholars.
2. Based on the incident descriptions and the recognised tendencies, the authors identified recurring themes for each of the statistically significant relationships.
3. Based on the recurring themes, the authors developed a classification scheme, which was discussed with other scholars.
4. The authors created descriptions for each category.

In Articles V and VI, in addition to the quantitative analysis, the stated reasons for not playing exergames were analysed qualitatively using inductive content analysis (Patton, 1990). First, all the reasons were read several times and preliminary categories were formed. Then, each reason was given a code that classified it under one of the categories. Similar reasons were classified under the same category. If a reason did not fit into any of the formed categories, a new category was formed. After all the reasons were classified, similar categories were combined into broader categories. The categories that consisted of only a few reasons were combined into a category called *other reasons*.

4 RESULTS

This section presents the core results of the articles in this thesis with the RQs they answer. Article I investigates the role of the situational context in post-experience use continuance of exergaming. Articles II, V, and VI examine the adoption and usage habits of exergames and the differences between the different backgrounds. In addition, Articles V and VI investigate the main reasons for not playing exergames and the differences between age and gender. Article III investigates the ability of exergames to promote physical fitness and physical activity. Article IV investigates the factors explaining the intentions to use exergames as part of one's physical activity, and Article VII examines the intentions to use more traditional sport technology.

4.1 Article I - The role of situational context in post-experience use continuance

> Kari, T., Salo, M. & Frank, L. 2016. Use Continuance After Critical Exergaming Incidents: The Role of Situational Context. (Submitted to European Journal of Information Systems)

This article answers RQ 4: 'How is the role of situational context in post-experience use continuance of exergaming?'

The article concentrates on examining the use continuance after critical exergaming incidents and the role of the situational context. More specifically, it proposes how are the relationships between specific situational characteristics (purpose of use, type of gaming platform, social setting, place, and exertion level) and use continuance of exergames. Additionally, the article offers explanations for the recognised relationships.

The study is based on a data set of 461 actual critical incidents of exergaming collected using the critical incident technique (CIT). The collected data were analysed using quantitative statistical analysis with an additional qualitative content analysis following the CIT procedures (Gremler, 2004) to explain the statistical findings.

The study shows that the use of exergames is indeed more likely to continue after a positive than a negative critical incident. Negative critical incidents led to discontinuance with the related exergame in as high as 44.3% of the cases. However, negative incidents rarely led to discontinuance with all exergames. Thus, a negative incident with a certain exergame is unlikely to influence use continuance with all exergames. Figure 3 summarises the findings regarding the statistically significant relationships and their explanatory characteristics.

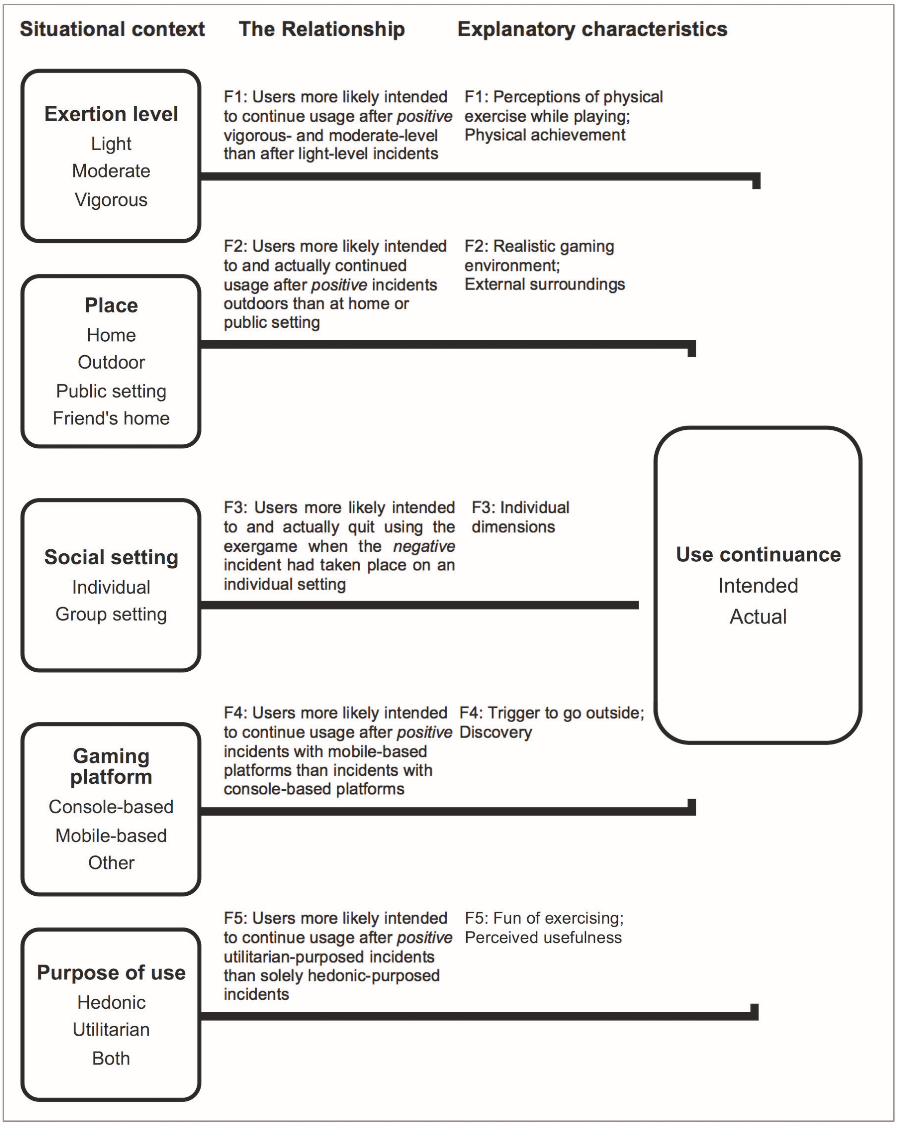

FIGURE 3 Summary of the main findings from Article I

Exertion level. There was a statistically significant difference between exertion level and intended use continuance but not between exertion level and actual use continuance. Users are more likely intended to continue the usage after positive moderate-to-vigorous level critical incidents than after positive light level incidents because of the perceptions of getting proper physical exercise by playing and reaching some physical achievement through playing. From a practical viewpoint, the findings regarding exertion level suggest that exergames should provide sufficient physical challenges for users, and designers should implement exergames with goals and achievements that are related to physical activity, not just game play. Additionally, highlighting the event of goal achievement could further wake positive feelings among users. These actions could promote those influential positive moderate-to-vigorous level incidents.

Place. A statistically significant difference was found between place and intended use continuance and between place and actual use continuance for the related exergame and for all exergames. Users are more likely to continue their usage after positive critical incidents that take place outdoors than after positive incidents in their own home or in a public setting because of the realistic gaming environment and external surroundings. From a practical viewpoint, designing exergames that use real-world places and outdoor surroundings as the game world, for example, through augmented reality, could lead to the next big thing of mobile gaming. Making design decisions with these factors in mind could promote those influential positive incidents.

Social setting. There was a statistically significant difference between social setting and intended use continuance and between social setting and actual use continuance of the related exergame, but not for all exergames. Users are more likely to discontinue their usage after negative critical incidents that take place in an individual setting than after negative incidents involving other people because of the individual dimensions of the experience. From a practical viewpoint, developers can affect the social setting of gaming by implementing multiplayer modes, although, this is not possible or feasible in all cases. However, as the group setting seems to somehow diminish the significance of the negative incident to the user, perhaps through social support, it might be a good idea to allow the user to send feedback directly from the in-game menu.

Gaming platform. The difference between the gaming platform and intended use continuance was statistically significant, but with actual use continuance, no statistically significant difference was evident. Users are more likely intended to continue their usage after positive critical incidents on a mobile-based platform than after positive incidents on a console-based platform because of the ability of mobile exergames to trigger users to go outside and the discovery of new areas. From a practical viewpoint, as the users reported that the mobile exergame had triggered them to go outside in the first place and that the immersion in a realistic outdoor environment made them engage in more physical effort and activity than they had planned, these kinds of descriptions would be beneficial for marketing actions. Additionally, making the gaming area as big as feasible could increase the chances of the user to experience the discovery of previously unknown areas or exceptional views.

Purpose of use. A statistically significant difference was found between purpose of use and intended use continuance; however no statistically significant difference was evident between purpose of use and actual use continuance. Users are more likely intended to continue their usage after positive critical incidents with utilitarian use purposes than after positive incidents with solely hedonic use purposes because of the combination of perceived usefulness and enjoyment of exercising. From a practical viewpoint, exergames that are designed for exercising should also be fun to play. The importance of this cannot be overemphasised. In addition, exergames that are designed to meet hedonic needs could also present the physical benefits of playing to the user, thus drawing the user's attention to the utilitarian benefits. Linked to the utilitarian-purposed use, it is also important to perceive the exergame as useful for exercising. Thus, the games designed for exercising should provide an adequate level of physical activity and present the development of the player's physical fitness.

These results also demonstrate that the relationships between specific situational characteristics and use continuance are asymmetrical; for example, place was influential when the experience was positive but not when it was negative.

The article contributes by extending current knowledge about the usage of exergames and other dual-purposed information systems by proposing how are the relationships between situational context (purpose of use, type of gaming platform, social setting, place, exertion level) and use continuance after critical exergaming incidents. The article provides first understanding about the previously unmapped area of how users behave situation-dependently after their critical exergaming incidents, and also uncovers the relationships between situational context and use continuance by distinguishing specific situational characteristics. Understanding such specific relationships helps researchers to zoom into the complex usage of exergames and other dual-purposed IS that occurs in a great variety of different use contexts. The main practical contribution is the implications for exergame providers and designers about different actions and aspects that would be valuable to consider in the development process. These implications can be beneficial not only for exergame providers but also for others developing dual-purposed IS.

4.2 Article II - Adoption and usage habits: Physical activity background and digital gaming frequency

Kari, T. 2015. Explaining the Adoption and Habits of Playing Exergames: The Role of Physical Activity Background and Digital Gaming Frequency. In Proceedings of the 21st Americas Conference on Information Systems (AMCIS) 2015.

This article answers RQ 2: 'How are exergames adopted and what are the usage habits of exergames' from the perspective of physical activity and gaming backgrounds.

The article concentrates on examining the adoption and habits of playing exergames, focusing particularly on whether, and how, the physical activity and gaming backgrounds are associated with the adoption and usage of these types of games. The physical activity and gaming backgrounds were examined through physical activity category and digital gaming frequency. The main aims of the study were to find out (1) the role of these backgrounds in the adoption of exergames and (2) how is the background associated with the usage habits of exergames.

The study is based on an online survey sample of 1,091 Finnish consumers. Regarding adoption, a respondent was defined as an adopter of exergames, if he or she stated to play exergames (n=319). The data concerning the habits of playing exergames were collected from these 319 respondents to ensure that the respondents had at least some experience with the games and could give responses based on actual usage. All the respondents, not just players, were also asked which type of exergaming (console- or mobile-based) they prefer or would prefer to use as a part of their exercise. For the analysis, two sub-samples were formed. One for physical activity background (n=1,054) and one for digital gaming frequency (n=1,057). Those respondents who could not state their physical activity background or their digital gaming frequency were excluded from the respective sub-sample along with those who could not state whether or not they played exergames. The collected data regarding the adoption and habits of playing were analysed using quantitative statistical analysis.

The article studies similar aspects to Articles V and VI, but with a newer data set. In accordance with those two articles, the study shows that playing (adoption of) exergames is almost equally common among men and women, and most popular (adopted) among the youngest examined age group (–19 years in this study) and least popular in the oldest examined age group (40– years in this study). When looking at the habits of playing exergames, the results indicate that exergames are most frequently played on console-based devices and relatively infrequently on mobile-based and other devices. In addition, users prefer console-based exergames to mobile-based exergames when using exergames as a part of their exercise. When considering the rising popularity of mobile gaming and wellness solutions, this highlights the market potential of mobile-based exergames, and also perhaps indicates that mobile-based exergames are not so well known and should thus be marketed more widely. The results also show that exergames are played more for hedonic than utilitarian reasons, more in a group than individual setting, most typically at a moderate or light exertion levels, and the effects of exergaming on physical fitness are not perceived as very efficient. Thus, it would be valuable to design exergames mainly with entertainment as a spearhead, and also implement multiplayer modes into the games. There also seems to be a demand for physically more demanding exergames as long as the entertainment aspect is retained.

Regarding the physical activity background, the respondents were asked to identify what type of physically active person they are by selecting from seven physical activity categories derived from the most recent Finnish National Sport Survey (FNSS) (Finnish Sports Federation, 2011). The physical activity background distribution was reasonably close to that of the FNSS. Table 1 presents the proportions of different groups in the physical activity background and digital gaming frequency sub-samples as well as the numbers and percentages of players in each group.

TABLE 1 Proportions of different groups in the sub-samples

	Whole Sample (N=1,091)		**FNSS sample**	**All Players (n=319)**		**% of players among sub-sample**	
	n	%	%	**n**	%	**n**	%
Physical activity background							
Competitive athlete	132	12.1	5.0	40	12.5	40/132	30.3
Recreational sportsman	277	25.4	19.0	81	25.5	81/277	29.2
Active for fitness	247	22.6	38.0	66	20.7	66/247	26.7
Active for health	137	12.6	15.0	40	12.5	40/137	29.2
Active in non-exercise	199	18.2	19.0	62	19.5	62/199	31.2
Occasionally active	78	7.1	3.0	25	7.8	25/78	32.1
Sedentary	11	1.0	1.0	3	0.9	3/11	27.3
N/A	10	0.9	0.0	2	0.6	2/10	20.0
Digital gaming frequency							
Daily	132	23.9		113	35.4	113/132	85.6
Weekly	287	26.3		106	33.2	106/287	36.9
Monthly	141	12.9		46	14.4	46/141	32.6
Less than monthly	192	17.6		44	13.8	44/192	22.9
Only tried	149	13.7		10	3.1	10/149	6.7
Never tried	53	4.9		0	0	0/53	0
N/A	8	0.7		0	0	0/8	0

In terms of the physical activity background differences on the adoption and habits of playing exergames, the results indicate no difference in the commonness of playing exergames. This indicates the market potential for exergames among all types of physically (more or less) active people. Additionally, regarding habits, physical activity background was found to be rather poor in explaining the playing of exergames, as the only habit in which there was a statistically significant difference was the exertion of playing. In general, the more physically active group the person categorised him or herself to belong in, the more likely he or she was to mainly play at a lighter exertion level. One explanation for this could be that for those with high physical fitness level, the games do not offer activities that are physically demanding enough, while for those with lower physical fitness level, the games provide more effective physical activity. This implies that exergames that are designed for exercising might be more suitable for people with lower levels of physical fitness, and if the target group is "very fit persons", the games should be made sufficiently physically demanding.

Compared to physical activity background, digital gaming frequency was found to better explain the playing of exergames. In terms of the differences in the adoption and habits of playing exergames based on digital gaming frequency background, the results indicate that the more frequently a respondent played any type of digital games, the more likely he or she was also to play (have adopted) exergames. This indicates that the most potential target group for exergames is found among those, who already are familiar with digital gaming. Similar to physical activity background, there was a statistically significant difference with the exertion of playing. It seems that the more often one plays any digital games, the more likely he or she is to play exergames at a more vigorous exertion level. This is actually the complete opposite to physical activity background, as the more physically active the person is, the more likely he or she is to play exergames at a lighter exertion level, while the more active the person is in digital gaming, the more likely he or she is to play exergames at a more vigorous exertion level. This implies that those who are "very active players" might be a more potential target group for physically demanding exergames, while casual players might be more open to exergames that are physically less demanding.

The article contributes to exergaming research and industry practice. The main theoretical contribution of the study comes from answering the previously unanswered questions about whether, and how, the physical activity and gaming backgrounds are associated with the adoption and usage of exergames, and which one of these better explains the adoption and playing of exergames. These are also important questions from a practical viewpoint; the answer can help the exergame industry, e.g. marketers and developers, in designing and promoting the games, thus advancing the adoption and diffusion of exergames. This could also help the society on a wider scale, as there is a clear need to find new ways to motivate people to live a more active and a healthier lifestyle, since the health benefits of physical activity and the health detriments of physical inactivity are well demonstrated (e.g. Lee et al., 2012; Warburton et al., 2006; WHO, 2010).

4.3 Article III - The ability to promote physical fitness and physical activity

Kari, T. 2014. Can Exergaming Promote Physical Fitness and Physical Activity?: A Systematic Review of Systematic Reviews. International Journal of Gaming and Computer-Mediated Simulations, 6(4), 59-77.

This article answers RQ 5: 'Can exergaming promote physical fitness and physical activity'.

The article concentrates on examining the effectiveness of exergaming on physical fitness and physical activity. The objective is to form a wide-range view of the effects that exergaming activities have on physical fitness and physical activity levels, and also to identify gaps in previous research. More precisely, the article aims to answer: (1) What levels of exertion are typical for exergaming? (2) Can exergaming contribute to increasing physical activity? and (3) Can exergaming be used to increase physical fitness?

The study is a systematic review of systematic reviews. Following previous guidelines for systematic reviews (Smith et al., 2011) and their reporting (Liberati et al., 2009; Moher et al., 2009), a systematic literature search was conducted on 10 databases. 1,040 articles were identified and retrieved based on the selected keywords, of which 68 articles were found potentially relevant. The quality of all relevant articles was evaluated using the AMSTAR tool (Shea et al., 2007; Shea et al., 2009). After all the duplicates were removed and inclusion, exclusion, and quality criteria were implemented, six articles remained for review. Figure 4 presents the flow of information through the different phases of this systematic review, as guided by the PRISMA statement (Liberati et al., 2009; Moher et al., 2009). The final six systematic reviews and meta-analysis articles had reviewed a total of 145 studies published between 2002 and 2013.

Of the six articles, two focused mainly on physical fitness and four on both physical fitness and physical activity. Four articles targeted children and youth, one targeted children and adults, and one targeted the elderly. All articles mainly focused on console-based exergaming and none focused mainly on mobile-based exergaming, most probably because mobile-based exergames are a rather novel concept; the majority of studies regarding exergaming to date have focused on console-based exergames.

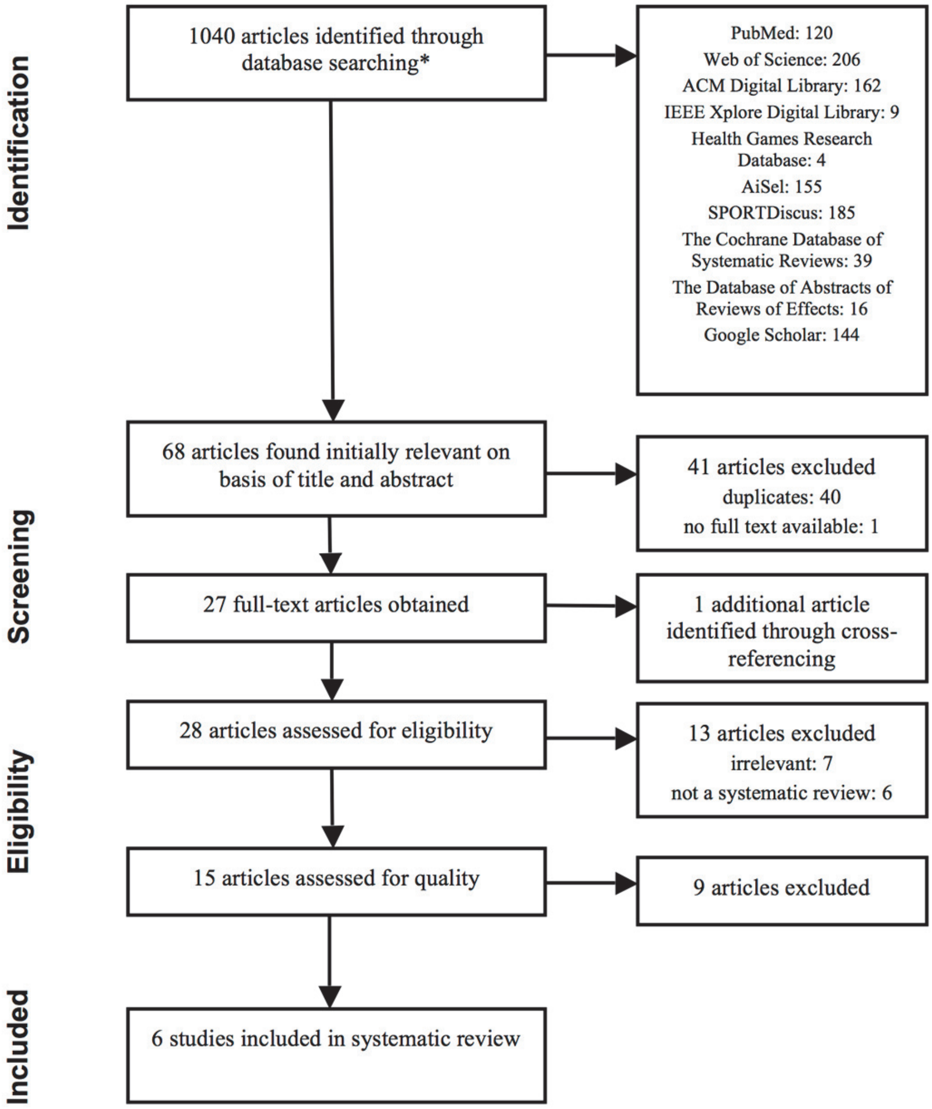

FIGURE 4 Flow diagram of study selection

Physical fitness. The articles presenting the results of the effects of exergaming on physical fitness provide a fairly consistent finding that the most typical level of exertion in exergaming is light-to-moderate (Barnett et al., 2011; Biddiss & Irwin, 2010; LeBlanc et al., 2013; Peng et al., 2013), with the average metabolic equivalent (MET) values being just over the moderate threshold of 3 METs (Barnett et al., 2011; Biddiss & Irwin, 2010; Peng et al., 2013). As such, exergaming can provide exertion that surpasses the minimum intensity level (3 METs) recommended by the U.S. Department of Health and Human Services (2008, vii). However, the level of exertion seems to depend on the ability of the game to provide exertion of adequate intensity (Barnett et al., 2011; Biddiss & Irwin, 2010) and on the player him or herself (Barnett et al., 2011; Biddiss & Irwin, 2010; Peng et al., 2013). Games that require lower body movement are more effective at increasing exertion level than games requiring only upper body movement, while games that require both are the most effective (Biddiss & Irwin, 2010; Peng et al., 2013). Additionally, the intensity with which the player chooses to play the game (Barnett et al., 2011), the skill level and gaming experience (Barnett et al., 2011; Peng et al., 2013), multiplayer participation (Biddiss & Irwin, 2010), and gender, age, and weight (Peng et al., 2013) may all have an impact. When looking at the longer-term effects of exergaming on physical fitness, the evidence of beneficial effects is limited, and current evidence does not support long-term benefits for physical fitness.

Physical activity. All four articles that focus on the effects of exergaming on physical activity present the consistent result that the evidence of exergaming contributing to increased physical activity is limited or inconclusive (Barnett et al., 2011; Biddiss & Irwin, 2010; LeBlanc et al., 2013; Peng et al., 2013). It seems that exergaming may increase physical activity and decrease sedentary behaviour in the short term; however, there is limited evidence to support the ability of exergaming to increase long-term physical activity. Nevertheless, three articles suggested that exergaming has the potential to replace some sedentary behaviour (Biddiss & Irwin, 2010; LeBlanc et al., 2013; Peng et al., 2013).

Perceptions. Five of the articles discussed the perceptions of exergaming. In general, children and youth (Biddiss & Irwin, 2010; LeBlanc et al., 2013), adults (Peng et al., 2013), and the elderly (Larsen et al., 2013) were reported to enjoy exergaming. LeBlanc et al. (2013) and Peng et al. (2013) also reported that exergaming was generally preferred over traditional exercises. Nevertheless, four of the five articles reported a decrease in exergaming play over time or during the interventions (Barnett et al., 2011; Biddiss & Irwin, 2010; LeBlanc et al., 2013; Peng et al., 2013). Peng et al. (2013) reported on the perceived exertion of exergaming. When compared to actual measured exertion levels, children found exergaming to be less physically demanding than it actually was (Peng et al., 2013). Two studies suggested that multiplayer features such as interaction with others or competitive play with peers might increase the participation in and maintenance of exergaming, at least among children and youth (Barnett et al., 2011; Biddiss & Irwin, 2010). These studies also reported on the facilitators and barriers to exergaming maintenance. The mentioned facilitators included competition, peer and family support, greater variety of music in a dance exergame (Barnett et al., 2011), enjoyment, and exergaming not being constrained by typical barriers to participation, such as a lack of transportation, seasonal conditions, or unsafe neighbourhoods (Biddiss & Irwin, 2010). Barriers included boredom, technical problems (Barnett et al., 2011) and difficulties, changes in living arrangements, and auditory nuisance (Biddiss & Irwin, 2010).

From a practical viewpoint, even though exergaming is generally enjoyed and can evoke some benefits for physical fitness and physical activity, the current evidence does not support the ability of exergaming to increase physical fitness or physical activity levels sufficiently for significant health benefits. Therefore, exergaming cannot be recommended as the only method for physical fitness and physical activity promotion, and other means of physical activity should be used alongside exergaming for significant physical fitness benefits. However, even if exergaming activity does not provide a sufficient level of physical activity, it can reduce the time spent on sedentary activities such as sitting, which in many studies (e.g. Lee et al., 2012; Matthews et al., 2012) has been identified as significantly increasing the risk of chronic diseases. Thus, exergaming can be recommended as a replacement to traditional video gaming activities that usually take place seated.

The article contributes by drawing together evidence from the highest quality systematic reviews on the ability of exergames to promote physical fitness and physical activity. Based on this evidence, the article presents practical implications regarding the use of exergames for physical fitness and physical activity promotion. The article also identifies gaps in previous research and suggests how to start addressing them.

4.4 Article IV - Usage intentions of exergames

> Kari, T. & Makkonen, M. 2014. Explaining the Usage Intentions of Exergames. In Proceedings of the 35th International Conference on Information Systems (ICIS) 2014.

This article answers RQ 1: ’What kinds of factors explain the intention to use exergames as part of one’s physical activity?’.

The article concentrates on examining what kinds of factors explain the intentions to use exergames as part of one’s exercise. The study follows a hypothetico-deductive research method: first, a new theoretical model for explaining the usage intentions of exergames is proposed and then the model is empirically tested. Similar to Article VII, the proposed model (Figure 5) stems from the synthesis of three distinct theoretical domains: the TPB by Ajzen (1985; 1991), the IDT by Rogers (2003), and the typology of consumer value (TCV) by Holbrook (1996; 1999). More precisely, following TPB, it was hypothesised that the *intention to use* exergames would be explained by three factors: attitude towards their usage, subjective norm towards their usage, and perceived behavioural control over their usage. In addition to explaining usage intention with the three aforementioned factors, the study also explains the attitude towards using exergames with the behavioural beliefs on the outcomes of usage, which were derived from the mentioned theories and the revised motivation for physical activity measure (MPAM-R) scale by Ryan et al. (1997).

The study is based on an online survey sample of 271 Finnish console-based exergame owners, which is used to test the proposed theoretical model using SEM. In addition to estimating the model, its goodness of fit and its validity and reliability at both construct and indicator levels was evaluated. After conducting a few minor model modifications, the model was found to exhibit a satisfactory goodness of fit with the data as well as satisfactory validity and reliability at both construct and indicator levels.

The performance of the model in terms of the proportion of explained variance was found to be exceptionally good, as it was able to explain about two thirds of the total variance in the intention to use exergames and more than half of the total variance in attitude towards their usage. Figure 6 presents the estimation results.

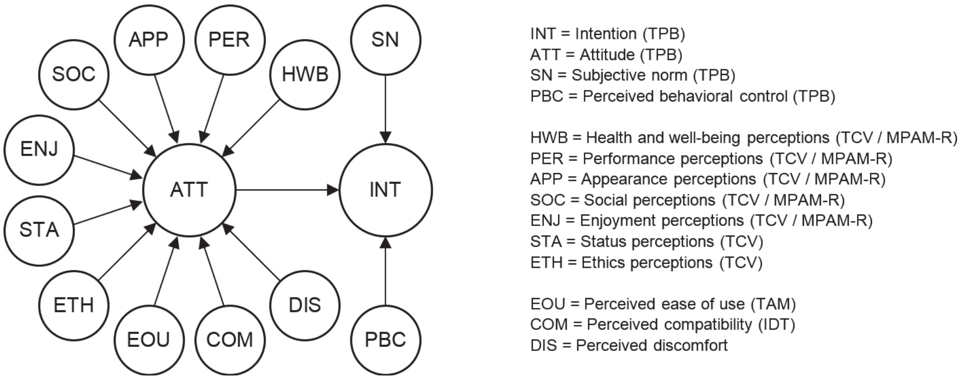

FIGURE 5 The theoretical model for explaining the usage intentions of exergames

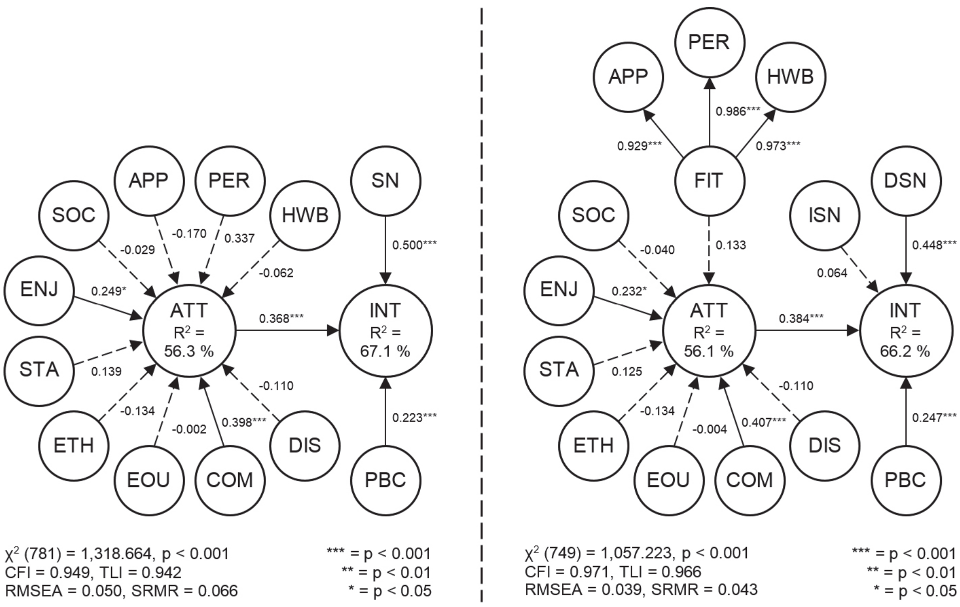

FIGURE 6 Estimation results before (left) and after (right) the model modifications

One of the key findings of the study concerns the relatively stronger effect of enjoyment perceptions on attitude towards using exergames compared to perceptions of physical fitness promotion. This suggests that attitude towards using exergames is driven more by the hedonic gaming aspects than by the utilitarian exercise aspects of games. In other words, people play the games mainly because they are fun, not because they promote one's physical fitness. From a practical viewpoint, the finding has important implications for not only how marketers of exergames should frame their marketing messages, but also how the developers of exergames should balance hedonic and utilitarian considerations when designing the games. For example, designing games that are very strenuous to play might maximise their effectiveness in terms of physical fitness promotion but it might simultaneously eliminate much of the fun element. Conversely, designing less strenuous games might make them more fun, especially for users who care little about physical activity, but it might also make them less useful from an exercise viewpoint.

A second key finding concerns the strong effect of perceived compatibility on attitude towards using exergames, which suggests that although exergames should be perceived as fun to play, they should also, and more importantly, be perceived as practical in terms of their compatibility with the current exercise habits of their users. In other words, instead of requiring significant changes to the ways the users currently exercise, they should rather try to support them as much as possible. From a practical viewpoint, this suggests that exergame developers and marketers should find out the current exercise habits of the users, for example, through different types of market studies, and then figure out ways to support them in the games.

A third key finding concerns the somewhat mixed role of the social environment as a driver of exergame usage. On the one hand, the weak effects of social perceptions, status perceptions, and ethics perceptions on attitude towards using exergames suggest that exergame usage is not so much driven by the goals of socialising with other people or influencing them by giving them a more active impression of oneself or inspiring them to exercise more. Similarly, the weak effect of injunctive subjective norm on the intention to use exergames suggests that exergame usage is also not particularly driven by other people's opinions in terms of the perceived social pressure to play or not to play them. On the other hand, other people's actual actions are a strong driver for exergame usage, as suggested by the strong effect of the descriptive subjective norm on the intention to use exergames. In other words, the more common people perceive exergaming to be in their social environment, the more likely they are to play exergames themselves. From a practical viewpoint, this finding implies that the developers and marketers of exergames are likely to benefit from various strategies that promote the perceived commonness or "trendiness" of exergaming in the society; notably, the more personal these strategies are, the more effective they are also likely to be. To achieve this, they could use, for example, traditional advertising campaigns that portray well-known athletes or other celebrities as enthusiastic players, or even better, make it seem like one's best friend or another person of particular importance is an enthusiastic exergamer.

A fourth key finding concerns the weak effects of perceived ease of use and perceived physical discomfort on attitude towards using exergames, which suggests that the easiness of playing games or the physical inconvenience they cause do not act as particularly strong drivers for their usage. These findings can be considered somewhat surprising when considering the prominent role that perceived ease of use has been proposed to play in the acceptance and use of technology in theories and models such as the technology acceptance model (TAM) (Davis, 1989) and the unified theory of acceptance and use of technology (UTAUT) (Venkatesh et al., 2003). One explanation for this could be that many of the survey respondents rated exergames as very easy to use and causing very little physical inconvenience, most likely because of the good user interface design of many modern exergames and their utilisation of user-friendly motion sensor technologies. Thus, perceived ease of use and perceived physical discomfort might actually have a much larger part to play as the drivers of using exergames than suggested above. From a practical viewpoint, one must keep in mind that perceived behavioural control, and particularly its capacity dimension, was found to have a fairly strong effect on the intention to use exergames, suggesting that exergame developers and marketers should promote users' perceptions of their capabilities to use exergames.

The article contributes to the user-centric stream of research on exergaming, which has been less studied in the past, and thus provides valuable insights regarding the users, user behaviour, and issues such as why users actually play these games. The understanding of these issues is crucial, especially for developers and marketers of exergames, in terms of developing better exergames that meet not only commercial success but also users' requirements, and thereby advancing their adoption and diffusion.

4.5 Article V - Adoption, usage habits and the reasons for not playing exergames: Age

Kari, T., Makkonen, M., Moilanen, P. & Frank, L. 2013. The Habits of Playing and the Reasons for Not Playing Exergames: Age Differences in Finland. International Journal on WWW/Internet, 11(1), 30-42.

This article answers RQ 2: 'How are exergames adopted and what are the usage habits of exergames' and RQ 3: 'What are the main reasons for not playing exergames' from the perspective of age.

The article concentrates on examining the habits of playing and the reasons for not playing exergames, focusing specifically on differences between four different age groups (–24 years, 25–34 years, 35–44 years, and 45– years) of players and non-players.

The study is based on an online survey sample of 3,036 Finnish consumers, out of which 2,976 stated whether or not they play exergames and were categorised into two sub-samples of *players* (n=723) and *non-players* (n=2,253) for the analysis. The *players* were asked descriptive questions about their habits of playing, whereas *non-players* were asked about their reasons for not playing. The collected data regarding the habits of playing were analysed using quantitative statistical analysis, and the data concerning the stated reasons for not playing exergames were analysed qualitatively using inductive content analysis (Patton, 1990).

Table 2 summarises the responses to the questions regarding the habits of playing exergames, first for all the players and then for the different age groups.

TABLE 2 Habits of playing exergames among different age groups

		All % (N = 723)	–24 yrs. % (n = 222)	25-34 yrs. % (n = 261)	35-44 yrs. % (n = 151)	45– yrs. % (n = 89)
Playing on game consoles	At least weekly	16.9	20.5	15.8	16.6	16.9
	At least monthly	26.6	25.0	26.3	29.8	26.6
	Less than monthly	54.4	53.2	56.4	51.7	54.4
	Has never played	2.1	1.4	1.5	2.0	2.1
	N/A	6	2	2	0	2
Playing on computers	At least weekly	3.0	3.8	2.3	0.7	7.1
	At least monthly	4.0	5.2	3.5	3.4	3.5
	Less than monthly	21.7	26.3	19.5	19.7	20.0
	Has never played	71.3	64.8	74.6	76.2	69.4
	N/A	22	9	5	4	4
Playing on mobile devices	At least weekly	1.6	4.2	0.0	1.4	0.0
	At least monthly	1.7	2.8	1.2	1.4	1.2
	Less than monthly	11.9	12.3	9.9	14.2	12.9
	Has never played	84.8	80.7	88.9	83.1	85.9
	N/A	26	10	9	3	4
Reasons of playing	Fun	85.3	83.4	84.9	90.7	81.4
	Exercise	14.7	16.6	15.1	9.3	18.6
	N/A	17	5	9	0	3
Setting of playing	Individual	22.1	25.0	22.4	16.0	25.0
	Group	77.9	75.0	77.6	84.0	75.0
	N/A	14	6	6	1	1
Exertion of playing	Light	34.3	30.7	34.8	35.1	40.7
	Moderate	61.1	65.1	60.0	60.1	55.8
	Vigorous	4.6	4.2	5.2	4.7	3.5
	N/A	27	10	11	3	3
Effects of playing	Negative	0.6	1.0	0.0	0.7	1.3
	No effects	81.5	79.2	80.8	87.0	80.0
	Positive	17.9	19.8	19.2	12.3	18.8
	N/A	74	25	27	13	9

Regarding the habits of playing exergames, the study shows that the most popular platform for playing exergames is game consoles, whereas playing them with computers or mobile devices is much less common. This is unsurprising when considering that a majority of exergames have been released for game consoles. However, this fact also highlights the market potential of the other platforms, particularly mobile devices, for which the penetration rates have been rather low. The results also suggest that exergames are mainly played for fun and in a group setting. Therefore, when designing the games, it is important to make them as entertaining as possible and, if reasonable, to include multiplayer features. The responses also indicate that exergames are mainly played at light-to-moderate exertion levels and that the playing of exergames is not generally perceived as having significant effects on physical fitness.

In terms of the age differences, the results indicate that playing of exergames is more common among younger individuals, and the likelihood of playing decreases with age. When examining the frequency of playing with different devices, age was found to have no dependency with playing exergames on game consoles or computers; however, the youngest age group were found to be more frequent players of exergames on mobile devices than those in the other age groups. There seems to be relatively small differences in the habits of playing exergames between different age groups, as age was found to have no dependency with the reasons, setting, exertion, or the perceived effects of playing.

Regarding the reasons for not playing exergames, 11 main reasons were identified: *no interest, prefers other forms of exercise, ownership, no money, not useful enough, not a gamer, no time, not familiar, home restrictions, personal restrictions, and other reasons*. The results show that the most significant reason for not playing exergames was a *lack of interest* towards them. The second most significant reason was that a person *prefers other forms of exercise* to exergames. The *lack of ownership* was the third most significant reason. The significance of different reasons was found to vary with respect to age groups. More specifically, in the youngest age group of people under 25 years, the three most significant reasons were (1) *no money*, (2) *ownership*, and (3) *prefers other forms of exercise*. In the age group of 25–34 years, the three most significant reasons were (1) *prefers other forms of exercise*, (2) *no interest*, and (3) *ownership*. In the two oldest age groups of 35–44 years and 45 years or over, the three most significant reasons were (1) *no interest*, (2) *prefers other forms of exercise*, and (3) *ownership*. As can be seen, the reasons *prefers other forms of exercise* and *ownership* were among the three most significant reasons in each age group, and, apart from the youngest age group, also the reason *no interest*. In the youngest age group, the most significant reason for not playing exergames was *no money*. The most significant differences between age groups were between the reasons *no money* and *no interest*. *No money* was more significant the younger the age group was, most probably because, in Finland, the degree of low income is highest among those aged under 25 years (Statistics Finland, 2012). On the contrary, the reason *no interest* was more significant the older the age group was; thus, marketers should create marketing activities aimed at older age groups to draw more interest in exergames among these age groups. One such marketing activity could be to use older and "regular" people in the commercials instead of athletes. Marketing activities aimed at older age groups could also be beneficial because the reason *no money* plays a less significant role among these age groups.

These results indicate that the exergaming industry still has some work to do before exergames are perceived interesting enough in terms of the gaming experience and useful enough in terms of their effects on physical fitness. The exergaming industry should therefore concentrate on addressing these issues in both the game design and marketing of exergames. Designers could design exergames that are more physically demanding, as this could result in them being perceived as more useful and more interesting. However, the games should not be made too physically demanding, as this might reduce the users' perceptions of the fun element. Marketers could emphasise the potential physical benefits of playing exergames. Overall, finding the equilibrium between the hedonic and utilitarian aspects of playing exergames and delivering this message to potential customers are the main challenges facing the exergame designers and the exergaming industry today, and most probably also in the future.

The article contributes to exergame research as it is among the first ones to study the actual habits and perceptions of exergame players (and non-players), the reasons for not playing them, and the age differences in an exergaming context. The results are valuable for the design and marketing of exergames. Thus, the article provides new insights for both the research community and the industry.

4.6 Article VI - Adoption, usage habits and the reasons for not playing exergames: Gender

Kari, T., Makkonen, M., Moilanen, P. & Frank, L. 2012. The Habits of Playing and the Reasons for Not Playing Exergames: Gender Differences in Finland. In U. Lechner, D. Wigand, & A. Pucihar (Eds.), Proceedings of the 25th Bled eConference 'eDependability: Reliable and Trustworthy eStructures, eProcesses, eOperations and eServices for the Future', 512-526.

This article answers RQ 2: 'How are exergames adopted and what are the usage habits of exergames' and RQ 3: 'What are the main reasons for not playing exergames' from the perspective of gender.

The article concentrates on examining the habits of playing and the reasons for not playing exergames, focusing particularly on the gender differences between the male and female players and non-players. More precisely, the article aims to answer: (1) What kinds of gender differences exist in the habits of playing exergames? and (2) What kinds of gender differences exist in the reasons for not playing exergames?

The study is based on the same data used in Article V; an online survey sample of 3,036 Finnish consumers, of which 2,976 stated whether or not they play exergames and were categorised into two sub-samples of *players* (n=723, 32.6% men) and *non-players* (n = 2,253, 36.6% men) for analysis. The *players* were asked descriptive questions about their habits of playing, and the *non-players* were asked about their reasons for not playing. The collected data regarding the habits of playing were analysed using quantitative statistical analysis, and the data concerning the stated reasons for not playing exergames were analysed qualitatively using inductive content analysis (Patton, 1990).

As this study uses the same data set as Article V, the general results and the following implications regarding the habits of playing and the reasons for not playing are similar. However, this study focuses on gender differences rather than the age differences studied in Article V. The study shows that the most popular platform for playing exergames is game consoles, and fewer people play exergames with computers or mobile devices. This finding is in line with the majority of exergames having been released for game consoles and highlights the market potential of other platforms, particularly mobile devices, for which the penetration rates have been fairly low. The results also suggest that exergames are mainly played for fun and in a group setting. Therefore, when designing the games, it is important to make them as entertaining as possible and, if feasible, equip them with good multiplayer features. The responses also suggest that exergames are played mainly at moderate or light exertion levels and that the playing of exergames is not perceived as having significant effects on physical fitness.

In terms of gender differences, the results indicate no difference in the popularity of playing exergames between men and women. Regarding the type of platform used, men and women played equally with game consoles; however, men were found to be more frequent players of games on computers and mobile devices than were women. Gender differences were found for the reasons of playing. Although men and women were both found to play exergames mainly for the hedonic reason of having fun, utilitarian exercise-related reasons were more popular among women than among men. This is in line with the finding that women play exergames at more vigorous exertion levels and perceive the effects of playing on their physical fitness more positively than men. Thus, if exergames are marketed more as a means of exercising than as a means of having fun, women can perhaps be considered more potential targets for these kinds of marketing messages.

In terms of the reasons for not playing exergames, 11 main reasons were identified: *no interest, prefers other forms of exercise, ownership, no money, not useful enough, not a gamer, no time, not familiar, home restrictions, personal restrictions, and other reasons*. Table 3 presents examples of the stated reasons that were classified into each category.

TABLE 3 Reasons for not playing exergames with examples

Reason for not playing	**Examples of stated reasons**
No interest	Not interested, does not motivate, do not like, do not care
Prefers other forms of exercise	Prefers exercising outside/in a group/by other forms
Ownership	Does not own, has not bought
No money	The price, too expensive, cannot afford
Not useful enough	Does not perceive useful, not demanding enough physically, no need
Not a gamer	Doesn't play any digital games, never played digital games
No time	Lack of time, not enough time, no free time for exergaming
Not familiar	Not familiar, has not even heard, unknown
Home restrictions	No space for exergaming/devices, neighbours
Personal restrictions	Age (too old), crippled, weight, physical/bodily restrictions

Some differences between men and women were found. Among men, the three most significant reasons for not playing were (1) *lack of interest*, (2) *prefers other forms of exercise*, and (3) *ownership*. Among women, the three most significant reasons for not playing were (1) *prefers other forms of exercise*, (2) *lack of interest*, and (3) *ownership*. In other words, the same reasons were cited but in a different order. The most significant difference between men and women was in the reason *no money*. As the income differences between men and women in Finland are relatively low in respect to the reasonably low prices of exergames, perhaps the main explanation for this finding is that women are less aware of the actual prices of exergames than are men.

The results indicate that exergames need to be developed further before they are perceived as interesting enough in terms of the gaming experience and useful enough in terms of their effects on physical fitness. Thus, the game industry should focus on addressing these issues in their game designs. One aspect that might aid in addressing these issues could be to make the games physically more demanding, as this could result in them being perceived as not only more useful but also as more interesting. Nevertheless, the games should not be made too physically demanding, as this could reduce the players' perceptions of the fun element. Overall, finding equilibrium between the hedonic and utilitarian aspects of exergames is the main challenge facing current game designers today, and most probably in the years to come.

The article contributes to exergame research as it is among the first to study the actual habits and perceptions of playing exergames, as well as the reasons for not playing them, with a focus on gender differences. The results are valuable for the design and marketing of exergames. Thus, the article provides important insights for both the research community and the industry.

4.7 Article VII - Intentions to use more traditional sports technology

Makkonen, M., Frank, L., Kari, T. & Moilanen, P. 2012. Explaining the Usage Intentions of Exercise Monitoring Devices: The Usage of Heart Rate Monitors in Finland. In Proceedings of the 18th Americas Conference on Information Systems (AMCIS) 2012.

This article provides additional information to Article IV and together they answer RQ 1 from the perspective of the 'Difference to more traditional sports technology'. By comparing the results of this article with those of Article IV, the differences in the factors explaining the usage intentions of exergames and more traditional sports technology are examined. These differences are discussed in the discussion section of this thesis.

The article concentrates on examining what kinds of factors explain the usage intentions of exercise monitoring devices. The study follows a hypothetico-deductive research method: first, a new theoretical model for explaining the usage intentions of exercise monitoring devices is proposed and then the model is empirically tested in the case of one common type of these devices: HRM. Similar to Article IV, the proposed model (Figure 7) is based on a synthesis of three distinct theoretical domains: the TPB by Ajzen (1985; 1991), the IDT by Rogers (2003), and the TCV by Holbrook (1996; 1999). More precisely, following TPB, it was hypothesised that the *usage intentions* of exercise monitoring devices would be explained by three factors: attitude towards their usage, subjective norm towards their usage, and perceived behavioural control over their usage. In addition, the study explains the attitude towards their usage with the behavioural beliefs on the outcomes of the usage, which were derived from the mentioned theories and the MPAM-R scale by Ryan et al. (1997).

The study is based on an online survey sample of 1,250 Finnish HRM owners, which is used to test the proposed theoretical model using SEM. In addition to estimating the model, the goodness of fit and its reliability and validity at both construct and indicator levels were evaluated. After conducting a minor model modification – eliminating two problematic indicators (SN1 and COM3) – the model was found to exhibit satisfactory goodness of fit, validity, and reliability when evaluated on model, construct, and indicator levels.

The model was found to perform very well, as it was able to explain more than 60% of the variance in the usage intentions of HRMs and more than 50% of the variance in the attitudes towards using HRMs. Figure 8 presents the estimation results.

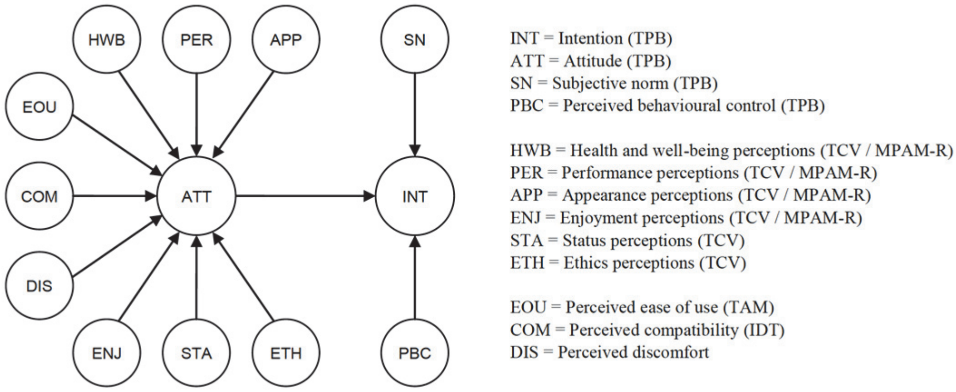

FIGURE 7 The model for explaining the usage intentions of exercise monitoring devices

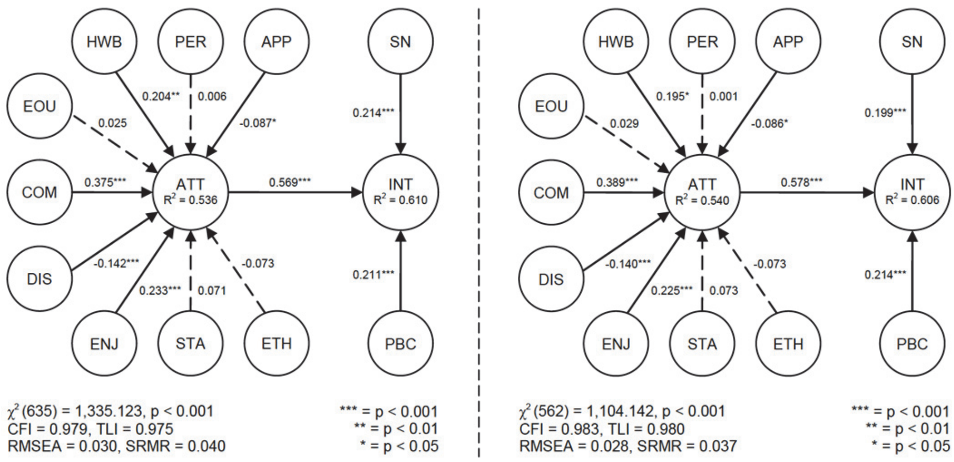

FIGURE 8 Estimation results before (left) and after (right) eliminating SN1 and COM3

The study suggests that the attitudes towards using HRMs are driven equally by the utilitarian perceptions of their ability to support the achievement of different types of health and well-being goals as well as the hedonic perceptions of their ability to make exercise more fun. Therefore, from a practical perspective, these aspects should be given equal attention in the design and marketing of HRMs. In design, this could mean, for example, the development of HRM software that includes both utilitarian features instructing the users in their training and hedonic features, such as exergames, which turn the training into more play than work.

Perceived compatibility and discomfort were found to be significant drivers of the attitudes towards using HRMs, with perceived compatibility having a positive effect and perceived discomfort having a negative effect on the attitudes. In addition, perceived behavioural control was found to have a positive effect on the usage intentions of HRMs. From a practical viewpoint, this finding implies that these aspects should be given adequate attention in the design of HRMs through design decisions that increase the perceived compatibility, decrease the perceived discomfort of the devices, and promote the perceptions of capacity, autonomy, and self-efficacy among the target users.

Social perceptions were found to have relatively insignificant effects on the usage of HRMs. For example, neither status nor ethics perceptions were found to have an effect on the attitudes towards their usage; however, subjective norm was found to have a positive effect on their usage intentions. From a practical perspective, this emphasises the potential of different types of word-of-mouth based techniques in the marketing of HRMs.

The main theoretical contribution of the article is the presented model as it not only promotes a theoretical understanding of the reasons behind the usage of exercise monitoring devices but also synthesises three distinct theoretical domains for explaining human behaviour – TPB, IDT, and TCV – into a new unified model, thus narrowing the theoretical gap between them. Derived from the estimation results, the main practical contributions of the study are the implications for the design and marketing of HRMs.

5 DISCUSSION

This section presents the key findings and contributions of the thesis. The findings are discussed and contributions for the scientific community and practitioners are presented. This section also discusses the limitations of the thesis and provides recommendations for future research.

From a theoretical perspective, the key findings of this thesis provide a new "*understanding of how things are*" and "*why they are as they are*" (Gregor, 2006, 624). Thus, the findings extend the current theoretical knowledge of exergaming and IS usage and consequently create new avenues for related research. From a practical perspective, the findings provide new insights that can be used to draw valuable practical implications to be utilised by several different stakeholders. Table 4 summarises the RQs, related key results, and contributions. The contributions of the thesis and their relation to previous research are presented and discussed in more detail in the included articles.

TABLE 4 Research questions and summary of results and contribution

Research question	Summary of results and contribution
RQ 1	
What kinds of factors explain the intention to use exergames as part of one's physical activity?	The presented model for explaining the usage intentions of exergames explains 66% of the variance in the intention to use exergames and 56% of the variance in attitude towards their usage. The intention is driven by attitude, descriptive subjective norm, and perceived behavioural control, while attitude is driven by enjoyment perceptions and perceived compatibility. The results provide valuable insights regarding the users and user behaviours that, in addition to research community, are crucial for developers and marketers of exergames.
Difference to more traditional sports technology?	The attitudes towards using traditional sports technology (e.g. HRMs) are driven equally by utilitarian perceptions and hedonic perceptions, whereas the attitudes towards using exergames are driven more by hedonic perceptions than utilitarian perceptions.

RQ 2	
How are exergames adopted and what are the usage habits of exergames – the differences between demographic backgrounds?	Exergames are mainly played for fun, in a group setting, and at light-to-moderate exertion levels. They are equally adopted between men and women as well as between different physical activity backgrounds, but the playing is more common among younger age groups and more active digital gamers. Background partly affects the habits and perceptions of exergaming. The new results lay foundation for future research and assist developers in finding the balance between the hedonic and utilitarian aspects of playing exergames and delivering this message to potential customers.
RQ 3	
What are the main reasons for not playing exergames – the differences between age and gender?	The most significant reasons for not playing exergames are the lack of interest towards them, prefers other forms of exercise to exergames, and lack of ownership. The main reasons are the same for both genders, but for men, the main reason is lack of interest and for women, prefers other forms of exercise. The same reasons are among the most significant ones also for all the age groups of >25 years, but for the age groups of <25 years, the main reason for not playing is no money. The results provide valuable first insights about the reasons hindering exergames play and can be considered critical, among others, for the design and marketing of exergames.
RQ 4	
How is the role of situational context in post-experience use continuance of exergaming?	Purpose of use, type of gaming platform, social setting, place, and exertion level as situational characteristics influence users' post-experience use continuance. For example, users are more likely to continue the usage after positive incidents outdoors than in their own home or a public setting, because of realistic gaming environment and external surroundings. The new results enable researchers to understand the role of specific situational settings that can steer human behaviour and practitioners in the gaming, health, and IS-related industries toward reaching the potential of exergames.
RQ 5	
Can exergaming promote physical fitness and physical activity?	Exergaming can provide exertion of the recommended intensity, is generally enjoyed, and can evoke some benefits for physical fitness and physical activity; however the current evidence does not support the ability of exergaming to increase the physical fitness or physical activity levels sufficiently for significant health benefits. However, it can reduce the time spent on sedentary activities such as sitting. As such, exergaming cannot be recommended as the only method for physical fitness and physical activity promotion, and other means of physical activity should be used alongside exergaming for significant physical fitness benefits. The results draw together evidence from the highest quality systematic reviews and based on this, pose practical implications regarding the use of exergames for physical fitness and physical activity promotion. The identified research gaps regarding related research aid scholars in planning their future studies.

5.1 Theoretical implications

This thesis demonstrates how the perceptions of exergames are and shows how they differ in different phases of the use cycle. With its focus on the less studied user-centric stream of research, this thesis fills several notable research gaps regarding the users, user behaviours, and the usage of exergames. Thus, this thesis provides valuable new knowledge to the scientific community and increases the theoretical understanding regarding exergames. Furthermore, as prior research aiming to extend IS knowledge has mostly employed approaches restricted to a rather general level, there is a demand for more specific knowledge to continue the advancement of the IS field (Grover & Lyytinen, 2015). Therefore, IS researchers have been called to develop and advance contextual theories and concentrate on more context-specific approaches (Grover & Lyytinen 2015; Venkatesh et al., 2012). This thesis does its part in answering this call by specifically focusing on the context of exergames with its different usage aspects. This context-specificity enables to gain a deeper understanding of the user behaviours within this specific context, which is considered valuable for both theory and practice (Burton-Jones & Straub, 2006; Venkatesh et al., 2012).

The research results of this thesis highlight the importance of enjoyment behind the usage intentions and the actual use of exergames; however, for the continued use of exergames, the perceptions of utilitarian benefit also have an important role.

Regarding usage intentions, hedonic enjoyment perceptions have a stronger effect on attitude towards using exergames compared to utilitarian perceptions of physical fitness promotion. This finding suggests that players engage with these games chiefly because they are fun, not because they promote physical fitness, thus supporting the finding of Lin et al. (2012). When comparing the results of Articles IV and VII regarding the drivers behind the intention to use either exergames or more traditional sports technology (in this case HRMs), it can be seen that while the attitudes towards using HRMs are driven equally by utilitarian and hedonic perceptions, the attitudes towards using exergames are driven more by hedonic perceptions than by utilitarian perceptions. Further, in addition to the enjoyment perceptions, the attitudes towards using exergames are driven by perceived compatibility, whereas the attitudes towards using HRMs are driven by appearance perceptions, health and well-being perceptions, perceived compatibility, perceived discomfort, and enjoyment perceptions. Regarding both exergames and HRMs, the intentions to use are driven by attitude, perceived behavioural control, and subjective norm. Although, at least with exergames, it would seem that it's precisely the descriptive subjective norm (the actual doings of other people) and not the injunctive subjective norm (the opinions of other people) that affects the intention to use exergames. This poses an important theoretical implication for the scientific community: when studying exergames, the hedonic nature of their usage compared to more traditional sports technology should be acknowledged.

The theoretical model presented in Article IV increases our understanding of exergaming and combines three distinct theoretical domains of human behaviour, TPB, TCV, and IDT into a new unified model, hence bridging the theoretical gap between them – similar to the model in Article VII regarding more traditional exercise technology. As stated by Venkatesh et al. (2012, 158) "*theories that focus on a specific context and identify relevant predictors and mechanisms are considered to be vital in providing a rich understanding of a focal phenomenon and to meaningfully extend theories*". Additionally, IS scholars could benefit from using the presented theoretical model to investigate the intention to use with attitude towards usage in other IS contexts as well.

While adoption and usage have been widely studied in the field of IS, the research in the specific context of exergaming has been limited. Thus, in terms of adoption and usage habits of exergames, this thesis provides answers to the previously unanswered questions on whether, and how, gender, age, and the physical activity and gaming backgrounds are associated with the adoption, usage habits, and perceptions of exergames, and it identifies the main reasons people have for not playing.

The thesis shows the importance of fun and enjoyment as the main reason for playing exergames. Exergames are mainly played in a group setting, which demonstrates the importance of the social aspects, not only for the players but also for the researchers to consider in their studies. This is in line with the finding that descriptive subjective norm (the actual actions of other people) affect the intention to use exergames. The subjective data (Articles II, V, and VI) and the data collected through a systematic review (Article III) provide a consistent finding that exergames are mainly played at light-to-moderate exertion levels. In terms of adoption, the results show that exergames are adopted equally between men and women as well as between different physical activity backgrounds, but exergame playing is more common among younger people and more active digital gamers. Background, especially gender, also partly affects the habits and perceptions of exergaming.

Regarding the reasons for not playing exergames, previous research has identified certain barriers to exergaming maintenance including boredom, technical issues (Barnett et al., 2011), living arrangements, and auditory nuisance (Biddiss & Irwin, 2010); however, a more precise investigation has been lacking. Therefore, the main reasons, with the gender and age differences identified in this thesis, complement those previous studies and provide a more detailed view of the reasons for not playing. More precisely, the most significant reasons for not playing exergames are a *lack of interest towards exergames*, *prefers other forms of exercise to exergames*, and *lack of ownership*. The main reasons are the same for men and women and for all but the youngest age groups (<25 years), for whom the most important reason is *no money*. However, it is to be noted that the recent rise of mobile-based exergames (e.g. Zombies, Run! and Pokémon GO) has probably changed this, as most of the mobile-based exergames in the market are free-to-play. Nevertheless, the reason *no money* most likely stands as the number one reason for not playing console-based exergames among the youngest age groups. These findings lay a foundation for researchers to delve deeper into some specific aspects of playing and not-playing exergames.

Regarding use continuance – or continued use – the thesis uncovers new knowledge about the relationships between specific situational characteristics and post-experience use continuance. As situational context has been shown to be a relevant yet under-researched aspect regarding IS usage and use continuance (Liang & Yeh, 2011; Salo & Frank, 2015; Venkatesh et al., 2011), studying its influence on use continuance, especially within an exergaming context, was much needed. Complementing previous research in a broad IS context and providing completely new context-specific knowledge regarding exergaming, the *purpose of use*, *type of gaming platform* (as the technology artefact), *social setting*, and *place,* as situational characteristics, are found to influence users' post-experience use continuance. In addition, *exertion level* is found to be influential and important. As the influence of exertion level to exergaming or IS use continuance has not been previously studied in academic research, the findings impart completely new knowledge in this regard and provide a good starting point for researchers in framing their future studies concerning exertion level as the user's situational state with exergaming or other IS.

These findings enable researchers to understand the role of specific situational settings that can crucially steer human behaviour. Furthermore, as the results (Article I) indicate that – in contrast to premises and assumptions applied in many previous studies on IS usage – the relationships between specific situational characteristics and post-experience use continuance are asymmetrical, researchers focusing on IS usage are encouraged to acknowledge and consider this asymmetry in their future studies.

Another important finding is that even though the intention to use and the actual usage are mainly driven by enjoyment aspects, users are more likely to continue their usage after positive incidents where the main purpose of use is either completely utilitarian or has simultaneously both utilitarian and hedonic use purposes compared to incidents with solely hedonic use purposes. Thus, the combination of perceived utilitarian benefit and the fun of exercising is an important factor for continued use of exergames. Such dual-purposed aspects have mostly been overlooked in previous IS research, where the purpose of use has been divided between only hedonic and utilitarian purposes. As only a few studies have touched the dual-purposed use of IS (Hong & Tam, 2006; Wu & Lu, 2013), future studies should consider such simultaneous dual-purposed use. By examining not only hedonic or utilitarian uses but also a simultaneous dual-purposed use, this thesis offers greatly required insights into this perspective.

The results from this thesis regarding the ability to promote physical fitness and physical activity are valuable to the scientific community studying these issues, as past findings have been quite mixed. By carefully following guidelines and systematically reviewing only the highest quality studies, there is strong reason to believe that potential false conclusions based on low quality research have been avoided, and the obtained results can be considered reliable.

Thus, the presented findings complement earlier research by presenting high quality evidence on the topic.

5.2 Practical implications

The practical implications are disclosed along four different beneficiaries: the developers of exergames, marketers of exergames, the public sector, and users.

Practical implications for developers. The results suggest that exergames are chiefly played for fun. Therefore, when designing the games, it is essential to make them as entertaining as possible. However, for the continued use of these games, the perceptions of the utilitarian benefits are also important. Thus, exergames that are designed mainly for entertainment should also in some way present the physical benefits of playing to the user, consequently waking the perceptions of the utilitarian benefits. Conversely, exergames that are designed mainly for exercising purposes should also be designed as fun to play. One aspect that might aid in addressing these aspects could be to make the games physically more demanding, as this could ensure they are perceived not only as more useful in terms of physical activity but also more interesting. However, the games should not be designed as too physically demanding as this could reduce the players' perceptions of the fun element. Thus, exergame designers should acknowledge that while designing the games to be physically less strenuous might make them more fun, especially for users who care little about physical activity, it might also make them less useful from the perspective of exercise. In addition, one way to arouse those utilitarian perceptions could be, for example, to implement dynamic skill levels or to provide real-time and long-term feedback on the player's physical activity and fitness through appropriate measures.

It seems that for those, whose physical fitness level is high, the games do not offer activity that is sufficiently physically challenging, while for those with lower level of fitness, the games yield more effective physical activity. This implies that exergames that are mainly designed for exercising purposes might be more fruitful among people with lower levels of physical fitness, and for target groups of more "fit" individuals, the games should be designed to provide adequate physical activity. This also implies that an exergame could reach a wider audience if it offered different skill levels for people with different levels of fitness to choose from. The games could also be implemented with goals and achievements related to physical activity, not just game play. Furthermore, highlighting these achievements could further raise those positive feelings among users that are influential regarding use continuance. In general, there seems to be a demand for physically more demanding exergames as long as the entertainment aspect is retained.

Exergames, especially those primarily aimed to foster physical activity, should be perceived as practical in terms of compatibility with the present exercise habits of their users. That is, exergames should try to support the ways the users currently exercise instead of requiring them to make significant changes. The resulting practical implication is that exergame developers and marketers should investigate and understand the present exercise habits of the target users or customers, for example, by conducting different types of market studies, and consider means to support them through games.

Exergaming usually takes place in a group setting. As the social setting is influential regarding use continuance, the games should be implemented with suitable multiplayer features, if feasible. In addition, as the group setting seems to diminish the significance of negative exergaming incidents to the user, possibly through social support or sharing, it might be worthwhile adding a feature that allows the user to send direct feedback from the in-game menu.

Exergame players seem to appreciate the possibility of playing these games outdoors. Hence, developing exergames that use outdoor surroundings and real-world locations as the game world – through, for example, augmented reality – could well lead to the next "big thing" of both exergaming and mobile gaming. In most cases, these outdoor games would require the gaming platform to be mobile. With mobile exergames, making the gaming area as large as feasible would increase the possibility of the users to venture further from their current locations and experience the discovery of previously unknown areas or exceptional views, which was found influential regarding use continuance. Designers are thus encouraged to develop mobile outdoor exergames.

Overall, exergames need to be perceived as interesting enough in terms of the gaming experience and useful enough in terms of their effects on physical fitness. Thus, it is essential that the game industry addresses these issues in game design. Finding equilibrium between the hedonic and utilitarian aspects of exergames is the main challenge the game designers need to overcome.

Practical implications for marketers. The findings regarding the reasons for not playing exergames imply that the public may have a somewhat incorrect view of exergames at some levels, which indicates that the providers of exergames have not been entirely successful in their marketing messages and in presenting and framing these kinds of games to the public. Better-formulated and more precisely aimed marketing messages could help the providers to reach a wider audience for their exergames and consequently increase the adoption and diffusion of exergames. Additionally, the huge popularity of mobile gaming and different mobile wellness applications highlights the market potential of mobile-based exergames and implies that mobile-based exergames are not so well known and should be marketed more extensively. Regarding the important role of enjoyment behind the usage intention and actual usage, exergames should be primarily marketed with the entertainment head. However, it would also be valuable to communicate the potential physical benefits of playing exergames on the side.

Compared to men, women seem to engage in exergaming at more vigorous exertion levels and perceive the physical effects of playing more positively. Thus, if exergames are marketed more as a means of exercising than as entertainment, women could be considered more potential targets for such marketing messages. Marketing campaigns could thus include varying adverts to target different genders.

Additionally, marketing actions aimed at older age groups could possibly increase overall knowledge and arouse greater interest in exergames among these age groups. For example, older and "regular" people could be used in the adverts instead of youngsters or athlete look-alikes. Especially as older people likely have less experience of gaming and novel technologies in general, framing the games as easy to use and socially acceptable would be wise. Exergames could also be marketed as means of balance training for older people. Reaching these age groups would be worthwhile, as they are a growing and a very large group of individuals with an increasing need for digital wellness solutions (Carlsson & Walden, 2015; Carlsson & Carlsson, 2016).

It seems that the more active the person is in digital gaming, the more likely exergaming occurs at a more vigorous exertion level. This implies that those more active gamers may be a more potential target group for physically more challenging exergames, whereas casual gamers may be more open to receiving physically less challenging exergames. This starts from the design board, but if the marketing channels vary between these groups, the message could be framed accordingly.

The actual behaviour of other people is a significant driver for exergame usage intention. The more common people perceive exergaming to be in their social environment, the more likely they are to play exergames themselves. This implies that marketing strategies that are able to promote the perceived commonness or trendiness of exergaming in society could be highly successful. Furthermore, the more personalised messages these strategies can deliver, the more effective they are also likely to be. To succeed in this, marketers could use advertising campaigns that portray celebrities or famous athletes (from different age groups) as enthusiastic players or preferably make it appear that one's closest friends or other persons of social importance are enthusiastic exergamers.

Practical implications for public sector. Considering the well-established health benefits of physical activity (e.g. Warburton et al., 2006; WHO, 2010) as well as the health detriments (e.g. Lee et al., 2012; Pesola et al., 2015; WHO, 2010) and the increasing healthcare costs (e.g. Ding et al., 2016; Kohl et al., 2012; Lee et al., 2012) caused by physical inactivity, it is paramount to find and research new ways to promote physical activity and prevent physical inactivity. Exergaming is a potential means to influence the physical activity levels. The findings of this thesis provide new insights into and a deeper understanding of the usage of exergames and can thus potentially benefit several different stakeholders in the public sector in their attempts to employ these games as tools for physical activity promotion. Additionally, the findings concerning the differences between usage intentions of exergames and more traditional sports technology can aid those utilising exergames for means of more traditional sports technologies. Thus, if the actors operating in these tasks utilise the findings of this thesis, it could potentially have beneficial effects for the public sector in terms of health and economics.

From a practical perspective, even though exergaming can provide exertion of recommended intensity, is generally enjoyed, and can induce some benefits for physical fitness and physical activity, the current evidence does not support the ability of exergaming to increase the physical fitness or physical activity levels sufficiently for significant health benefits. However, exergaming can reduce the time consumed by sedentary activities. As such, exergaming cannot be recommended as the only method for physical fitness and physical activity promotion, and other forms of physical activity should be used alongside exergaming for significant physical fitness benefits. However, even if exergaming activities do not provide a sufficient level of physical activity in the long term, they can reduce the time spent on sedentary activities such as sitting, which many studies (e.g. Lee et al., 2012; Matthews et al., 2012) have identified as significantly increasing the risk of chronic diseases. Replacing sitting with standing can benefit people by substantially increasing the overall daily muscle activity (Tikkanen et al., 2013). Thus, exergaming can be recommended as a replacement to traditional video gaming activities and other sedentary forms of entertainment that usually take place seated. As the proportion of exergamers is almost equal among different physical activity groups, practitioners could encourage physically less active individuals to engage in more physical activity using exergames. Exergames that are played outdoors with mobile devices could especially be used to motivate people towards more physical activity.

Overall, society should support the development of exergames and other games for health, as their increased adoption and diffusion could replace sedentary gaming and other sedentary behaviours and thus replace those detrimental health effects of sedentary gaming with positive effects of active gaming.

Practical implications for users. The users of exergames should give active feedback about the games to the developers should they, for example, encounter issues with the games or have views on how to make the games more intriguing. Interested users could also contact developers or answer public calls and present their interest to take part in testing programs of the games. Such direct user feedback is usually considered valuable and may contribute to the success of IS development (Venkatesh et al., 2011).

Another implication goes to people who are interested in their own health, but for one reason or another do not consider physical activity as very captivating. They could try exergaming, as the possible enjoyment and immersion of gaming could make them receive physical activity on the side without them really even noticing it. Further, replacing some sedentary gaming or other sedentary activities with exergaming would be beneficial. Even playing exergames at a light exertion level would decrease the detrimental health effects of sedentary time and sitting.

To sum up, exergame providers and developers can benefit from using the implications of this thesis to develop better and more captivating exergames that achieve commercial success, will be played for a longer period, and match both the hedonic and utilitarian needs of users. This thesis also provides information from which practitioners can benefit when planning how exergames and other dual-purposed IS can be more efficiently used for the purpose of good in different sectors of society. A more detailed view of the practical implications of the findings in this thesis is presented in the included articles.

5.3 Limitations

This thesis has some limitations. Some of these limitations provide suggestions for future research, presented in the Section 5.4. The main limitations of this thesis are discussed based on measuring adoption and habits, the reasons for not playing, a systematic review, the presented theoretical models, situational context, and data collection.

The limitations regarding measuring adoption and habits of exergaming relate to conceptualising adoption as a relatively simplified construct, as it was categorised into just two classes of adopters (players) and non-adopters (non-players), instead of also examining the relative time and degree of adoption. Regarding habit, operationalising some of the examined concepts (e.g. the reason, exertion perceived effects of playing, and setting) was done in a relatively simplified way, as those were examined with single item measures. These measures also focused on subjective perceived measures instead of objective measures of the concepts (e.g. *perceived* effects of playing and *perceived* exertion of playing). The possible relationships between the concepts were not examined.

Regarding the reasons for not playing, the main limitation comes from using an online survey for data collection, which did not allow asking follow-up questions about the presented reasons and might have led to some of the respondents giving a somewhat simple description of the reasons or not presenting all the reasons. However, the respondents could present their reasons freely (in response to an open-ended question) and were offered the possibility to give as many reasons as they wished. Certain reasons were also related to each other, possibly through causal relations (e.g. some individuals may lack interest toward exergames because they do not perceive them as useful enough). However, this study did not investigate the relationships between the reasons.

Regarding the conducted systematic review, the search strategy aimed for maximal coverage of appropriate articles, but it is still possible – although not likely – that not every relevant article was found. There also exists a common limitation regarding systematic reviews that the limitations of the included articles might affect the results of the systematic review. To avoid this, all the relevant articles were assessed for quality using the AMSTAR tool and only articles of good quality were included. None of the included articles focused on mobile-based exergaming, and thus the findings can only be considered in respect to console-based exergaming. Notable strengths of the conducted systematic review include the methodology that was based on proven guidelines and its *a priori* research design.

The presented theoretical models for explaining the usage intentions were developed by following a very deductive approach, which synthesised prior theories on human behaviour. The models also concentrated solely on the behavioural beliefs affecting the formation of attitude towards usage, instead of also the control beliefs and normative beliefs, which act as antecedents to perceived behavioural control and subjective norm. The article with the model regarding exergames focused solely on the owners of console-based exergames, thus limiting the generalisability to mobile-based exergames.

Regarding the situational context (Article I), as the information about context can in theory be limitless (Chávez et al., 1999), it is not possible to include an all-inclusive selection of situational characteristics. However, the selected characteristics are considered the most important ones that are most essential to understand.

Another limitation is that the different data sets used in the articles were collected solely from Finnish consumers, which somewhat limits the generalisability of the findings. Additionally, most of the data gathered from the respondents were subjectively collected; that is, the respondents' answers were self-reported. Self-reporting is always subject to recall or reinterpretation bias. Owing to the data collection methods used and ethical viewpoints, children were not reached. Online surveys also have the limitation of only being able to reach those with Internet access. However, as exergames are novel digital products, it is probable that most, if not all, exergame users also have access to Internet. Hence, it is likely that no target respondents were ruled out due to not having access to Internet. Naturally, every research method has its own limitations. In utilising the selected researched methods in the thesis, previous guidelines were adhered to. Therefore, there is no reason to believe that the utilised research methods had any bearing to the achieved results.

The limitations are discussed in more detail in the respective sections of the articles. Despite the reported limitations, the thesis manages to fulfil the task of answering the research questions and provides valuable theoretical insights and practical implications.

5.4 Recommendations for future research

The thesis and the presented findings open new and important paths for future research. A good starting point could be to address the limitations of this thesis or build future research on the presented findings to extend the theoretical knowledge on exergames and IS use in general.

Regarding habits, future studies could benefit from more rigorous operationalisation of the habit concepts by measuring them with multiple questions and evaluating the validity and reliability of the measures.

In addition to the used grouping criteria in Articles II, V, and VI (physical activity background, digital gaming frequency, age, gender), future studies could benefit from using some additional criteria to group the data (e.g. criteria concerning users' hedonic/utilitarian motives). This could provide additional insights into the role of significant background factors regarding the adoption and playing of exergames.

Regarding the theoretical models for explaining the usage intentions of exergames and HRMs, future research could also cover the control beliefs and normative beliefs in addition to the behavioural beliefs. Future research might also benefit from extending these models to cover actual usage in addition to usage intention. Measuring the potential direct effects of behavioural, control, and normative beliefs on usage intention in addition to the indirect effects through attitude, perceived behavioural control, and subjective norm, could also provide interesting results. Further, a more inductive approach, such as empirically surveying the owners of exergames or other IS to ascertain what kinds of behavioural beliefs affect the formation of their attitudes towards using could be worthwhile. Such inquiries could assist future studies to find completely new constructs that could be used to create even better models for explaining the adoption, usage, and other aspects of user behaviour in the context of exergames and IS.

The thesis uncovers several significant relationships between specific situational characteristics and use continuance, allowing future research to focus specifically on the nature of some particular relationships and the underlying contextual characteristics. In addition, considering the findings about the asymmetric role of the relationships, researchers focusing on IS usage should acknowledge and consider this duality in their future studies. It could also be beneficial to combine situational characteristics (e.g. social setting and place as social outdoor incidents) or choose a specific type of exergame for closer investigation. For example, significant relationships could be different with mobile-based exergames compared with console-based exergames. Future research could also study the relationships between the context and other post-experience behaviours (e.g. switching or word-of-mouth) in addition to use continuance.

One fruitful future research area could also be to investigate the results of this thesis in relation to health behaviour change support systems or more generally in relation to health behaviour change.

The research gaps in previous research regarding the promotion of physical fitness and physical activity (identified in Article III) propose that scholars should conduct more research on mobile-based exergaming, include adults and the elderly, and measure long-term effects, as notable gaps exist. Further, when conducting systematic reviews on exergaming, more attention should be paid to the quality and reporting of the research.

Future studies could build on this thesis by using other data collection methods, such as face-to-face interviews or focus groups, and by using additional data analysis methods. This would perhaps provide additional insights into users' experiences regarding exergames. Future research could also repeat the studies in this thesis with data collected from countries other than Finland.

An additional potential path for future research could be to focus on the actual design and development of exergames as well as on the interconnections between these and user behaviour domains. For example, how the formed understanding and knowledge on user behaviour could be systematically incorporated into good design and development decisions during the development of these games, or, as the hedonic aspects are a major driver of exergame usage, how exergames can be designed and developed to be more pleasing and enjoyable from the users' perspective.

Researchers are encouraged to use the findings of this thesis and the presented recommendations for future research in their pursuit of new knowledge regarding exergames and IS in general.

YHTEENVETO (FINNISH SUMMARY)

Yhteiskunnassa on kasvava tarve tietojärjestelmille, joiden avulla voitaisiin vaikuttaa ihmisten terveyskäyttäytymiseen myönteisesti. Digitaalisen pelaamisen on yleisesti ajateltu lisäävän ihmisten passiivista aikaa, mutta pelaaminen voi myös toimia välineenä terveyden edistämiseen, esimerkiksi fyysisen aktiivisuuden kautta. Digitaaliset liikuntapelit (exergames) yhdistävät pelaamisen ja liikunnan vaatimalla pelaajalta fyysistä aktiivisuutta pelin pelaamiseen. Pelien ohjaaminen tapahtuu omaa kehoa liikuttamalla ja pelin lopputulos määräytyy pelaajan fyysisten liikkeiden perusteella. Digitaaliset liikuntapelit on mainittu potentiaalisena keinona vaikuttaa ihmisten liikunta-aktiivisuuteen.

Aiempi digitaalisia liikuntapelejä koskeva tutkimus on pääosin keskittynyt laitekeskeiseen näkökulmaan koskien niiden teknisiä ja liikunnallisia aspekteja. Samalla käyttäjäkeskeisempi näkökulma, jossa tutkitaan käyttäjiä ja käytön eri ulottuvuuksia, on jäänyt selvästi vähemmälle. Tällaiselle tutkimuksen käyttäjäkeskeiselle lähestymistavalle on tarvetta, jotta digitaalisten liikuntapelien tunnistettu, mutta toistaiseksi saavuttamaton potentiaali mm. liikunta-aktiivisuuden merkittävässä lisäämisessä saavutettaisiin. Tietojärjestelmien käyttöä koskevan tutkimuksen tärkeyttä on toistuvasti korostettu, ja ymmärryksen lisääminen niiden käyttöä kohtaan on erittäin tärkeää niin käytännön toimijoille kuin tutkijoillekin.

Tämä väitöskirja vastaa edellä kuvattuun tutkimusaukkoon keskittymällä käyttäjäkeskeiseen näkökulmaan. Väitöskirja tarkastelee käytön keskeisiä puolia sen eri vaiheissa: käyttöaikomusta, omaksumista, käyttötapoja, syitä käyttämättömyydelle, käytön jatkuvuutta, sekä merkittäviä käyttöön liittyviä kokemuksia. Lisäksi väitöskirja tarkastelee digitaalisten liikuntapelien potentiaalia fyysisen aktiivisuuden ja fyysisen kunnon edistämisessä. Väitöskirjan empiirinen osuus sisältää sekä määrällisiä että laadullisia tutkimuksia, jotka on raportoitu seitsemässä tieteellisessä artikkelissa.

Väitöskirja osoittaa millaisia näkemykset digitaalisia liikuntapelejä kohtaan ovat ja miten ne eroavat käytön eri vaiheissa. Tulokset korostavat hedonististen huviin perustuvien näkemysten ja syiden tärkeyttä käyttöaikomuksen ja käytön taustalla, mutta käytön jatkuvuuden kannalta myös utilitaristiset hyötyyn perustuvat näkemykset ja kokemukset ovat merkittävässä roolissa. Digitaalisten liikuntapelien keskeinen vahvuus on huvin ja hyödyn yhdistäminen ja monelle se toimiikin pelaamisen lähtökohtana. Näin pelit voivat tarjota pelaajilleen liikuntaa ikään kuin pelaamisen sivutuotteena ilman, että pelaaja välttämättä edes kokee harrastavansa liikuntaa, ja siten toimia osalle keinona tehdä liikunnan harrastamisesta hauskempaa.

Väitöskirjan keskeinen teoreettinen kontribuutio on sen luoma arvokas uusi tieto tieteelliselle yhteisölle ja teoreettisen ymmärryksen lisääminen digitaalisten liikuntapelien käytöstä. Väitöskirja tarjoaa myös useita sen löydöksiin pohjautuvia päätelmiä ja suosituksia eri käytännön toimijoille pelien kehittäjistä käyttäjiin ja julkiselle sektorille. Nämä suositukset edesauttavat parempien pelien kehittämistä ja niiden hyödyntämistä terveyttä edistäviin tarkoituksiin.

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ORIGINAL ARTICLES

I

USE CONTINUANCE AFTER CRITICAL EXERGAMING INCIDENTS: THE ROLE OF SITUATIONAL CONTEXT

by

Tuomas Kari, Markus Salo & Lauri Frank, 2016

Submitted to European Journal of Information Systems

Use Continuance After Critical Exergaming Incidents: An Exploratory Study on the Role of Situational Context

Abstract

Exergames are increasingly popular digital gaming concepts combining exercise and games. Researchers have highlighted their potential in providing health benefits for their users, revenues for the providers, and well-being for societies. However, their potential remains unreached because users of exergames tend to discontinue use after their experiences. Such use continuance and discontinuance is influenced by critical incidents, which are users' unusually positive or negative experiences with products and services. One essential aspect that differentiates critical incidents is the situational use context. Yet, there exists no research on the relationships between situational context and use continuance after critical exergaming incidents. To address this gap, we conduct an exploratory study to uncover use continuance after critical exergaming incidents and the role of situational context. We examine quantitatively and qualitatively 461 actual critical exergaming incidents collected with the critical incident technique. Based on our results, we extend current knowledge about the usage of exergames and other dual-purposed information systems by proposing how are the relationships between situational context (purpose of use, type of gaming platform, social setting, place, exertion level) and use continuance after critical exergaming incidents. We also present practical implications to help providers in reaching the potential of exergames.

Keywords: Exergaming, Situational Context, User Behaviour, Use Continuance, Critical Incident Technique

II

EXPLAINING THE ADOPTION AND HABITS OF PLAYING EXER-GAMES: THE ROLE OF PHYSICAL ACTIVITY BACKGROUND AND DIGITAL GAMING FREQUENCY

by

Tuomas Kari, 2015

Proceedings of the 21st Americas Conference on Information Systems (AMCIS 2015),
13 pages

Explaining the Adoption and Habits of Playing Exergames: The Role of Physical Activity Background and Digital Gaming Frequency

Full papers

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Abstract

Exergaming, a form of digital gaming that combines physical exercise and video games, has become increasingly common in recent years. Exergaming has also become a subject of growing interest among academic researchers. They can be used to motivate people towards more active and a healthier lifestyle. This study examines the adoption and habits of playing exergames, focusing especially on whether and how exercise and gaming backgrounds are associated with the usage of these types of games. The study is based on analyzing an online survey sample of 1,091 respondents through contingency tables, the Pearson's $\chi 2$ tests of independence, and the Cramér's V coefficients. The results reveal interesting findings concerning the adoption and habits of playing exergames. Digital gaming frequency is found better in explaining these compared to physical activity background, with some interesting differences. These results can also be used to draw implications for the design and marketing of exergames.

Keywords

Exergames, Active video games, Habits of playing, Adoption, Online survey

Introduction

Exergaming, also knows as active video gaming (AVG), is a form of digital gaming that combines physical exercise and video gaming. This is done through the game mechanics, so that the playing of the game requires some sort of physical activity (PA) from the player. Kari and Makkonen (2014, pp. 2) define exergaming as "a form of digital gaming requiring aerobic physical effort – exceeding sedentary activity level and including strength-, balance-, or flexibility-related activity – from the player that determines the outcome of the game". The present study adheres to this definition of exergaming. One thing that makes exergames interesting is that they can be used for both hedonic reasons, such as entertainment or fun, or for utilitarian reasons, such as exercise and promoting physical activity and health (Osorio et al., 2012), or for both simultaneously (Berkovsky et al. 2010). Exergames can offer other advantages as well. One is that they can promote the physical activity of the players without the players having a deep understanding on physical exercise (Bogost 2005). They can also be used in several different settings (Baranowski et al. 2014; Lieberman et al. 2011), and be played with different devices (Kari and Makkonen 2014). The most popular devices for exergaming are the commercially available console-based devices (e.g., Xbox, Wii, and PlayStation) and mobile-based devices (smart phones and tablets) (Chamberlin and Maloney 2013). There are also other types of exergames, such as those found in arcades or gyms. Exergames have led to video gaming being viewed as a possible catalyst for increasing physical activity instead of just a sedentary activity that increases screen-time (Krause and Benavidez 2014).

The allure of video gaming, along with the fact that video gaming has come to be one of the most popular entertainment mediums in the world, and the potential of exergaming in e.g. promoting a healthier lifestyle (Maddison et al. 2013), has made exergaming grown into a significant research area both under information systems (IS) and game studies. This has led exergaming to gain an increasing amount of interest among academic researchers, for example, in terms of promoting a more active and a healthier lifestyle (Maddison et al. 2013). Most of the studies have focused on their potential to promote physical activity (e.g., Baranowski et al. 2012; Jenney et al. 2013; Kari 2014; LeBlanc et al. 2013; Peng et al. 2013; Trost et al. 2014) or on the physical effects of these games (e.g., Bethea et al. 2012; Howe et al. 2014; Kari 2014; Larsen et al. 2013; Lyons et al. 2011; Maddison et al. 2007; Peng et al. 2011; Scheer et al. 2014; Staiano and Calvert 2011). However, there is lack of research on who the exergame players actually are, especially from the aspect that are these games played more by sports people or gaming people. As the games combine both exercise and gaming concepts, it is important to recognize whether and how the exercise or gaming background is associated with the adoption and usage of these types of games.

In this study, the exercise and gaming backgrounds are examined through physical activity and digital gaming frequency. The main aims of the study are to find out 1) what is the role of these backgrounds in the adoption of exergames, and 2) how is the background associated with the usage habits of exergames. This also allows drawing a conclusion on which one of these explains the adoption and playing of exergames better. These can be considered important questions, as the answer can help the exergame industry e.g. marketers and developers in designing and promoting the games. Thus advancing the adoption and diffusion of exergames. This way it could also help the society in a wider scale, as there is a clear need to find new ways to motivate people towards more active and a healthier lifestyle, as the health benefits of physical activity as well as the health consequences of physical inactivity are well demonstrated (e.g., Lee et al. 2012; Warburton et al. 2006; World Health Organization (WHO) 2010, pp. 10). Because of the lack of prior research on the subject, the study is explorative in nature, meaning that the habits of playing exergames are examined at a descriptive level without utilizing any prior theoretical framework. In this study, habit refers to the *ways (how) people use IS*.

The paper consists of five main sections. After this introductory section, the theoretical background is described, followed by the methodology, results, and the conclusion sections. Finally, the limitations of the study together with potential paths for future research are presented.

Theoretical Background

Because of the explorative nature of this study, any *a priori* hypotheses on how exercise and gaming backgrounds are expected to be associated with the adoption of exergames (e.g., positively vs. negatively or linearly vs. non-linearly) are not proposed. However, as a theoretical argument for why these kinds of relationships are expected to exist, the innovation diffusion theory (IDT) (Rogers 2003) is utilized. IDT aims to explain how new ideas, products, and services spread in a social system. According to IDT, the diffusion of an innovation is hypothesized to occur through a step-by-step process over time, meaning that the time when an individual of a social system adopts an innovation is expected to vary. The main determinant for this is the so-called innovativeness of an individual, a persistent trait reflecting "individual's underlying nature when exposed to an innovation" (Yi et al. 2006, pp. 394). This innovativeness can be further divided into domain-specific innovativeness and global-specific innovativeness (Goldsmith et al. 1995). However, both two types of innovativeness are essentially hypothesized to have the same effect: the more innovative an individual is, the earlier he or she is to adopt the innovation in question.

To examine the determinants of innovativeness, individuals are typically classified into adopter categories based on the relative earliness/lateness that the individual adopts an innovation in the social system. In IDT, adopters are classified into five different adopter categories: innovators, early adopters, early majority, late majority, and laggards. When the individuals in an adopter category are examined in more detail, some common traits and qualities typically emerge. In IDT, these traits are classified into three categories: socioeconomic characteristics, personality variables, and communication behavior.

From the socioeconomic category, the adoption rates of exergames are briefly examined by two basic variables: age and gender. However, as the main focus of the study is on exercise and gaming backgrounds, which can be seen as personality variables, the study not only investigates the associations of exercise and gaming backgrounds on the adoption of exergames, but also more specifically focuses on how these backgrounds are associated with the usage habits of exergames.

In IS research, habit is often conceptualized as repeated behavioral sequences automatically triggered by environmental cues (Cheung and Limayem 2005; Limayem et al. 2003) or "the extent to which using a particular IS has become automatic in response to certain situations" (Limayem et al. 2003, pp. 2). However, in this study, habit refers, not to the habitual automatically triggered usage, but to the different *ways people use* IS and *how people use* IS, in this case exergames (e.g., the frequency of playing, the reason of playing, the setting of playing, and the physical exertion level of playing). Similar conceptualization of habit has been previously used in IS research by e.g. Böhler & Schüz (2004), Komulainen et al. (2008) and Lehtinen et al. (2009).

Methodology

To collect the data, an online survey was conducted among Finnish consumers. Online survey was selected as the data collection method because of its effectiveness in gathering the large amount of quantitative data that was required by the study. The survey was created by using the LimeSurvey 2.00+ software. Before the survey was launched, the questionnaire was pre-tested quantitatively with 87 undergraduate students and qualitatively with five IS and sports science researchers. Based on the received feedback, a few minor modifications were made. The final questionnaire was online for two months during October–December 2013. During this period, the survey was actively promoted by posting a survey link on several Finnish discussion forums focusing on a variety of topics, sending invitation e-mails through the communication channels of our university, and sharing the link in social media. To raise the response rate, the respondents who completed the survey were given the opportunity to take part in a drawing of six gift cards with a total worth of 160 €.

The survey questionnaire consisted of several sections, and the total number of questionnaire items presented to each respondent varied depending on their responses. Some of the sections and some of the items were conditional. For example, the data concerning the habits of playing exergames was collected only from the players, i.e. respondents who stated to be playing exergames. This was to ensure that the respondents had at least some experience with the games and could give responses based on actual usage. Of course, a respondent also had an option to not answer this question at all, in which case he or she was skipped to the next section. Regarding adoption, a respondent was defined as an adopter of exergames, if he or she stated to be playing exergames. The questionnaire sections used in this study focused specifically on the exercise habits of the respondents and their usage of exergames. The items in these sections are presented in Appendix A (translated from Finnish to English).

The descriptive questions concerning exergaming usage habits were all closed-ended multiple choice questions and concerned, for example, the frequency of playing exergames on console-, mobile-, and other platforms (daily, at least weekly, at least monthly, less frequently than monthly, has only tried, or has never played), the reason of playing (mainly for hedonic or mainly for utilitarian purposes), the setting of playing (mainly in an individual setting or mainly in a group setting), the physical exertion level of playing (light, moderate, or vigorous), and the perceived effects of playing on physical fitness (negative, no effects, or positive). All the respondents, not just players, were also asked which type of exergaming (console- or mobile based) they prefer or would prefer to use as a part of their exercise. The respondents also had the response option "cannot say" with these questions. The studied habits were selected by identifying from previous literature the most common different ways that exergames can be played.

The descriptive questions about the PA background and digital gaming frequency were also closed-ended multiple choice questions. The question regarding the frequency of playing digital games in general was asked similarly than with exergames. In the question regarding the PA background, the respondents were asked to state the type of physically active person they are by selecting between seven PA categories. The categories were derived from the most recent Finnish National Sport Survey (FNSS) (Finnish Sports Federation 2011) and included, ordered from highest PA level to lowest PA level, the following: competitive athlete, recreational sportsman, physically active for fitness, physically active for health, active in commuting and non-exercise, occasionally active, and sedentary. The categories are explained in more detail in Appendix B (translated from Finnish to English). For the analysis, two sub-samples were formed. One for PA background (N = 1054) and one for digital gaming frequency (N = 1057). Those respondents, who could not state their PA background or digital gaming frequency, were excluded from the respective sub-sample, together with those who could not state whether or not they play exergames.

The collected data was analyzed by using the IBM SPSS Statistics 22 software. The statistical significance and strength of the dependencies between the responses and exercise and gaming backgrounds were analyzed through contingency tables (crosstabs), the Pearson's $\chi 2$ tests of independence, and the Cramér's V coefficients. In some cases the common condition for the validity of $\chi 2$ test of "No more than 20% of the expected counts are less than 5 and all individual expected counts are 1 or greater" (Yates et al. 1999, pp. 734) was not met. Thus, by following the widely used guidelines suggested by Cochran (1954) and Agresti (2002), the results of Pearson's $\chi 2$ tests of independence were advanced by using exact tests (Monte Carlo). Monte Carlo (Mehta and Patel 2012) test was based on a 10 000 sampled tables and 99 % confidence level. This procedure is considered reliable and independent of the dimension, distribution, allocation and the balance of the analyzed data (Mehta and Patel 2012). The level of significance was set to $p \leq 0.050$. These methods enabled to examine both the linear and the non-linear dependencies, which suited the explorative nature of the study very well.

Results

The survey received 1,091 valid responses. Descriptive statistics of the whole sample of 1,091 respondents are presented in Table 1. In terms of the gender distributions, the sample can be characterized as very balanced. However, probably due to the nature of the topic and the way the survey was promoted, the age and income distributions of the sample were tilted toward younger respondents with lower income levels, most of whom were still full-time students in terms of their socioeconomic status. This bias was also reflected by the mean age of the respondents, which was 31.1 years (SD = 12.7 years) in the whole sample. However, the sample consisted of a relatively high number of respondents who classified themselves as active players of exergames. Of the 1,091 respondents, 319 (29.2 %) stated to be players of exergames and 745 (68.3 %) non-players, while 27 (2.5 %) could not state whether or not they play exergames. The number and percentage of players among different gender-, age-, yearly income-, and socioeconomic group sub-samples are also presented in Table 1. Proportions of different groups in the PA background and digital gaming frequency sub-samples as well as the number and percentage of players in these are presented in Table 2. The PA background distribution was reasonably close to that of the Finnish National Sport Survey as can be seen from Table 2.

	Whole sample (N = 1091)		**Players (N = 319)**		**% of players among sub-sample**	
	N	**%**	**N**	**%**	**N**	**%**
Gender						
Male	506	46.4	147	46.1	147/506	29.1
Female	585	53.6	172	53.9	172/585	29.4
Age						
–19 yrs.	133	12.2	57	17.9	57/133	42.9
20–29 yrs.	498	45.6	151	47.3	151/498	30.3
30–39 yrs.	225	20.6	72	22.6	72/225	32.0
40– yrs.	235	21.5	39	12.2	39/235	16.6
Yearly income						
–14,999 €	498	45.6	157	49.2	157/498	31.5

15,000–29,999 €	163	14.9	42	13.2	42/163	25.8
30,000–44,999 €	177	16.2	41	12.9	41/177	23.2
45,000– €	109	10.0	34	10.7	34/109	31.2
N/A	144	13.2	45	14.1	45/144	31.3
Socioeconomic group						
Student	540	49.5	176	55.2	176/540	32.6
Employed	434	39.8	122	38.2	122/434	28.1
Unemployed	51	4.7	10	3.1	10/51	19.6
Pensioner	45	4.1	0	0	0/45	0
Other	21	1.9	11	3.4	11/21	52.4
Playing exergames						
Yes	319	29.2	319	100		
No	745	68.3	0	0		
N/A	27	2.5	0	0		

Table 1. Descriptive Statistics of the Whole Sample

As can be seen from Table 1, playing (adoption) of exergames is almost equally common among men and women, as around 29 % of both sexes in the whole sample stated to be players of exergames and the difference was not statistically significant ($\chi2$ (2) = 0.390, p = 0.823). However, there was a statistically significant difference ($\chi2$ (6) = 36.560, p < 0.001, V = 0.129) in the popularity of playing exergames between different age groups. Exergaming was most popular (adopted) (42.9 %) among the youngest examined age group and least popular (16.6 %) in the oldest examined age group. In the two middle age groups the popularity (30.3 % and 32.0 %) was in between the youngest and oldest age groups.

	Whole Sample (N = 1091)		**FNSS sample**	**All Players (N = 319)**		**% of players among sub-sample**	
	N	**%**	**%**	**N**	**%**	**N**	**%**
PA background							
Competitive athlete	132	12.1	5.0	40	12.5	40/132	30.3
Recreational sportsman	277	25.4	19.0	81	25.5	81/277	29.2
Active for fitness	247	22.6	38.0	66	20.7	66/247	26.7
Active for health	137	12.6	15.0	40	12.5	40/137	29.2
Active in non-exercise	199	18.2	19.0	62	19.5	62/199	31.2
Occasionally active	78	7.1	3.0	25	7.8	25/78	32.1
Sedentary	11	1.0	1.0	3	0.9	3/11	27.3
N/A	10	0.9	0.0	2	0.6	2/10	20.0
Digital gaming frequency							
Daily	132	23.9		113	35.4	113/132	85.6
Weekly	287	26.3		106	33.2	106/287	36.9
Monthly	141	12.9		46	14.4	46/141	32.6

Less than monthly	192	17.6		44	13.8	44/192	22.9
Only tried	149	13.7		10	3.1	10/149	6.7
Never tried	53	4.9		0	0	0/53	0
N/A	8	0.7		0	0	0/8	0

Table 2. Proportions of Different Groups in the Sub-samples

As can be seen from Table 2, the proportions of different PA backgrounds among exergame players and the whole sample are very close to each other. However, there are clear differences in the proportions of digital gaming frequency groups between exergame players and the whole sample. In the next two subsections, these and the exergaming habits among the players (adopters) are examined in more detail. First, between different PA background groups, and then, based on the digital gaming frequency.

Habits of Playing Exergames - PA Background

The responses to the descriptive questions about the habits of playing exergames between different PA backgrounds are examined next. Those respondents (10) who could not state their PA background (two of them players) or whether or not they play exergames (27) were excluded from this sub-sample. This lead to N = 1054 for the examined sub-sample. Of those 1054 respondents, 317 (30.1 %) stated to be players of exergames and 737 (69.9 %) stated not to play exergames. When tested with the Pearson's χ^2 test of independence, the dependency between PA background and the playing (adoption) of exergames was not statistically significant (χ^2 (6) = 1.450, p = 0.963). Actually the percentages of exergame players in different PA background groups were surprisingly close to each other, as can be seen from Table 2.

Table 3 summarizes the results of the Pearson's χ^2 tests of independence and Monte Carlo exact tests that were used to examine the statistical significance and strength of the dependencies between PA background and the responses in this sub-sample. The first row refers to adoption, while the rest of the rows refer to different habits. Those who stated 'Cannot say' on the habit in questions were excluded.

	N	χ^2	df	p	$p_{(\text{Monte Carlo})}$	V
Playing exergames (adoption)	1054	1.450	6	0.963	0.963	0.037
Preferred platform	1054	5.537	6	0.477	0.473	0.072
Playing on game consoles	316	22.411	30	0.839	0.801	0.119
Playing on mobile devices	316	29.870	30	0.472	0.455	0.137
Playing on other devices	258	30.310	30	0.450	0.399	0.153
Reason of playing	306	6.278	6	0.393	0.383	0.143
Setting of playing	311	13.976	12	0.302	0.283	0.150
Exertion of playing	312	48.782	12	**< 0.001**	**< 0.001**	**0.280**
Effects of playing	298	27.465	24	0.283	0.226	0.152

Table 3. PA Background Dependencies in the Habits of Playing Exergames Among the Players

As can be seen, the only habit in which there was a statistically significant dependency with PA background was the exertion of playing ($\chi^2(12) = 48.782$, $p < 0.001$, V = 0.280). The most typical exertion levels of playing are moderate (59.0 %) and light (31.4 %) with only 9.6 % playing them mainly at a vigorous level. In general, the more physically active group the person categorized him or herself to belong in, the more likely he or she was to mainly play at a light exertion level. However, the only group in which the most common exertion level of playing was light was the *Competitive athlete* group with 56.4 % playing mainly at a light exertion level. Playing mainly at a moderate level was most common in the lower activity level groups *Active for health* (80.0 %), *Active for non-exercise* (80.3 %), and *Occasionally active*

(76.0 %). In addition to these, the groups in which the most common exertion level of playing was moderate were the *Recreational sportsman* (44.9 %) and *Active for fitness* (51.5 %) groups. Playing mainly at a vigorous level was most common in the *Recreational sportsman* (14.1 %) and *Occasionally active* (16.0 %) groups, but it was not the most common exertion level of playing in any of the groups. In the *Sedentary* group each exertion level was equally popular.

Regarding the other habits, in which there was no statistically significant dependency with PA background, the responses suggest the following. 1) The preferred gaming type to be used as a part of exercise is console-based exergames (66.1 %) which are preferred over mobile-based exergames (33.9 %). 2) Exergames are most frequently played on console-based devices and relatively infrequently on mobile and other devices. Of the players who responded these questions, 40.5 % stated that they were playing console-based exergames at least monthly, 12.4 % stated that they were playing mobile-based exergames at least monthly, and 7.4 % stated that they were playing them on other devices at least monthly. 3) Exergames are played more for hedonic than utilitarian reasons as 86.6 % stated to be playing them mainly for fun and 13.4 % mainly for exercise. 4) Exergames are played more in a group setting (67.8 %) than in an individual (30.2 %) setting. Playing with others over Internet is much less popular as only 1.9 % stated that to be the main setting of playing. 5) The effects of exergaming on physical fitness are not perceived as very efficient as the majority (70.8 %) stated to have perceived no effects. 27.8 % stated to have perceived positive effects and 1.3 % stated to have perceived negative effects.

Habits of Playing Exergames - Digital Gaming Frequency

The responses to the descriptive questions about the habits of playing exergames between digital gaming frequency backgrounds are examined next. Those respondents who could not state their digital gaming frequency (8) or whether or not they play exergames (27) were excluded from this sub-sample. One respondent could not state either. This lead to N = 1057 for the examined sub-sample. Of those 1057 respondents, 319 (30.2 %) stated to be players of exergames and 738 (69.8 %) stated not to play exergames. When tested with the Pearson's χ^2 test of independence, the dependency between digital gaming frequency and the playing (adoption) of exergames was statistically significant (χ^2 (5) = 97.264, p < 0.001, V = 0.303). The more frequently a respondent played any type of digital games, the more likely he or she was also to play exergames, as can be seen from Table 2.

Table 4 summarizes the results of the Pearson's χ^2 tests of independence and Monte Carlo exact tests that were used to examine the statistical significance and strength of the dependencies between digital gaming frequency and the responses in this sub-sample. The first row refers to adoption, while the rest of the rows refer to different habits. Those who stated 'Cannot say' on the habit in questions were excluded.

	N	χ^2	df	p	$p_{(\text{Monte Carlo})}$	V
Playing exergames (adoption)	1057	97.264	5	**< 0.001**	**< 0.001**	**0.303**
Preferred platform	1057	4.112	5	0.533	0.536	0.062
Playing on game consoles	318	62.506	20	**< 0.001**	**< 0.001**	**0.222**
Playing on mobile devices	318	34.678	20	**0.022**	**0.030**	**0.165**
Playing on other devices	260	21.919	20	0.345	0.334	0.145
Reason of playing	308	5.169	4	0.270	0.257	0.130
Setting of playing	313	9.992	8	0.266	0.256	0.126
Exertion of playing	314	26.881	8	**0.001**	**0.001**	**0.207**
Effects of playing	299	25.965	16	0.055	0.077	0.147

Table 4. Digital Gaming Frequency Dependencies in the Habits of Playing Exergames Among the Players

As can be seen, the habits in which there was a statistically significant dependency with digital gaming frequency were playing on game consoles ($\chi^2(20) = 62.506$, $p < 0.001$, $V = 0.222$), playing on mobile devices ($\chi^2(20) = 34.678$, $p = 0.022$, $V = 0.165$), and the exertion of playing ($\chi^2(8) = 26.881$, $p = 0.001$, $V = 0.207$).

As with the other sample, exergames were most frequently played on console-based devices and relatively infrequently on mobile-based devices. Of the players who responded these questions, 40.3 % stated that they were playing console-based exergames at least monthly, and 12.2 % stated that they were playing mobile-based exergames at least monthly. The higher the digital gaming frequency was, the more common playing console-based exergames also was. Those who played any digital games *daily* covered 46.1 % of those who played console-based exergames at least monthly, while *weekly* players covered 32.0 %, and *monthly* players 16.4 %. Leaving less frequent players to cover 5.5 % of those who played console-based exergames at least monthly. The results were almost similar with mobile-based exergames as those who played any digital games *daily* covered 33.3 % of those who played mobile-based exergames at least monthly, while *weekly* players covered 46.2 %, and *monthly* players 15.4 %. Leaving those who played less frequently to cover 5.1 %.

Naturally also in this sample, the most typical exertion levels of playing exergames were moderate (58.9 %) and light (31.5 %) with only 9.6 % playing them mainly at a vigorous level. Moderate was the most common level of exertion in all of the digital gaming frequency groups, except among those who had only tried them. Interestingly, of those who played exergames mainly at a vigorous level, 70 % were *daily* players of any digital games and 23.3 % *weekly* players. Of those whose main exertion level of exergaming was moderate, 33.0 % were *daily*, 33.0 % *weekly*, 15.7 % *monthly*, and 18.4 % less frequent players. Of those playing mainly at a light exertion level, 37.4 % were *weekly* players, 29.3 % *daily* players, 15.2 % *monthly* players, and 18.2 % less frequent players. This indicates that the more often one plays any digital games, the more likely he or she is to play exergames at a more vigorous exertion level.

Regarding the other habits, in which there was no statistically significant dependency with digital gaming frequency, the responses are naturally very similar to those of the other sample (PA background) as the respondents in these two samples were almost the same. That is, the preferred gaming type to be used as a part of exercise is console-based exergames, exergames are played mainly for fun, in a group setting, and the effects on physical fitness are not perceived as very efficient.

Conclusion

This study examined the adoption and habits of playing exergames, focusing especially on whether and how the exercise and gaming backgrounds are associated with the adoption and usage of these types of games. The exercise and gaming backgrounds were examined through physical activity and digital gaming frequency. The main aims of the study were to find out 1) what is the role of these backgrounds in the adoption of exergames, and 2) how is the background associated with the usage habits of exergames.

According to the results, playing (adoption) of exergames is almost equally common among men and women as around 29 % of both sexes in the whole sample stated to be players of exergames. Exergaming was also found to be most popular (adopted) among the youngest examined age group (–19 yrs.) and least popular in the oldest examined age group (40– yrs.). These findings are similar with Kari et al. (2012; 2013).

When looking at the habits of playing exergames, the results indicate that exergames are most frequently played on console-based devices and relatively infrequently on mobile-based and other devices. Also, when using exergames as a part of exercise, console-based exergames are preferred over mobile-based exergames. When considering the rising popularity of mobile gaming and wellness solutions, this highlights the market potential of mobile-based exergames, and also perhaps indicates that mobile-based exergames are not so well known and should be marketed more widely. The results also show that exergames are played more for hedonic than utilitarian reasons, more in a group than individual setting, most typically at a moderate or light exertion levels, and the effects of exergaming on physical fitness are not perceived as very efficient. Thus, it would be valuable to design exergames mainly with entertainment as a spearhead, and also implement multiplayer modes into the games. There would also seem to be a demand for physically more demanding exergames as long as the entertainment aspect is kept in mind.

The main theoretical contribution of the study comes from answering the previously unanswered questions on whether and how the exercise and gaming backgrounds are associated with the adoption and usage of these types of games.

In terms of the PA background differences in the adoption and habits of playing exergames, the results indicate no difference in the commonness of playing exergames between different PA background groups. Actually the percentages of exergame players (adopters) in different PA background groups seem to be surprisingly close to each other. This indicates that there is market potential for exergames among all types of physically (more or less) active people. Also with habits, PA background was found to be rather poor in explaining the playing of exergames, as the only habit in which there was a statistically significant difference was the exertion of playing. In general, the more physically active group the person categorized him or herself to belong in, the more likely he or she was to mainly play at a lighter exertion level. One explanation for this could be that for those, whose fitness level is high, the games don't offer activity that is physically demanding enough, while for those with lower level of fitness the games can provide more effective physical activity. This implies that exergames that are meant for exercising might be more suitable for people with lower levels of physical fitness, and if the target group would happen to be "very fit persons", then the games should be designed as physically demanding enough.

When compared to PA background, digital gaming frequency was found to better explain the playing of exergames. In terms of the differences in the adoption and habits of playing exergames by digital gaming frequency background, the results indicate that the more frequently a respondent played any type of digital games, the more likely he or she was also to play (have adopted) exergames. This indicates that the most potential target group for exergames is found among those, who already are familiar with digital gaming. In addition, there was also dependency in the habits of playing exergames on both game consoles and on mobile devices with the digital gaming frequency. The higher the digital gaming frequency was, the more common playing console-based exergames also was. The result was almost similar with mobile-based exergames. This could also be taken into account when marketing these games. Similar to PA background, there was a statistically significant difference with the exertion of playing. Interestingly, it seems that the more often one plays any digital games, the more likely he or she is to play exergames at a more vigorous exertion level. This is actually the complete opposite when compared to PA background. The more physically active the person is, the more likely he or she is to play exergames at a lighter exertion level, while as the more active the person is in digital gaming, the more likely he or she is to play exergames at a more vigorous exertion level. This implies that those who are "very active players" might be a more potential target group for physically demanding exergames, while casual players might be more open to exergames that are physically less demanding.

Limitations and Future Research

The main limitation of this study relates to the operationalization of some of the surveyed concepts, such as the reason, setting, exertion, and perceived effects of playing, in a relatively simplistic manner, as they were measured with single item measures. These measures also concentrated on subjective perceived measures rather than on objective measures of the concepts. Thus, future research could benefit from more rigorous operationalization in which the concepts are measured with multiple questions, making it possible to evaluate the reliability and validity of the measures. Also, due to the used evaluation technique, the relationships between the concepts were not examined in this study. Another limitation is the conceptualization of adoption as a rather simplified construct as it was classified into only two categories, adopters (players) and non-adopters (non-players), instead of also considering the relative time and degree of adoption. It should also be noted that the used grouping criteria is only one way to examine the collected data, and future research could benefit from using other criteria for the data grouping (for example based on individuals' hedonic/utilitarian motives) and thus produce further insights on the role of relevant background factors for the playing/adoption of exergames. In addition to addressing the mentioned limitations, future studies could also build on this study by using other data collection methods, such as interviews, and by using more advanced data analysis methods.

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Appendix A. Questions regarding the adoption and habits of playing exergames

1. Do you play digital exercise games?

- Yes
- No
- Cannot say

(In the analysis, this question was used to measure the adoption of exergames)

2. On average, how often do you play digital exercise games with the following devices?

	Daily	Weekly	Monthly	Less than monthly	Only tried once or twice	Never tried	Cannot say
Game console	○	○	○	○	○	○	○
Computer	○	○	○	○	○	○	○
Smart phone	○	○	○	○	○	○	○
Tablet	○	○	○	○	○	○	○
Other device	○	○	○	○	○	○	○

(In the analysis, game console and computer were combined as *console-based* and smart phone and tablet were combined as *mobile-based*)

3. Do you play digital exercise games mainly for fun or for exercise?

- Mainly for fun
- Mainly for exercise
- Cannot say

(In the analysis, 'Mainly for fun' was used for measuring *hedonic* motives, and 'Mainly for exercise' was used for measuring *utilitarian* motives)

4. Do you play digital exercise games mainly alone or together with other people?

- Mainly alone
- Mainly together with other people physically in the same space
- Mainly together with other people virtually over a network
- Cannot say

5. At what physical exertion level do you mainly play digital exercise games?

- Light (no sweating or accelerated breathing)
- Moderate (some sweating and accelerated breathing)
- Vigorous (strong sweating and accelerated breathing)
- Cannot say

6. How do you perceive that the playing of digital exercise games has affected your physical fitness?

- Significantly negatively
- Somewhat negatively
- No significant effect
- Somewhat positively
- Significantly positively
- Cannot say

7. Which of the following types of exergames you prefer (or would prefer) to use as a part of exercise?

- Console-based exergames
- Mobile-based exergames

Appendix B. Questions regarding the PA background and digital gaming frequency

1. In which of the following physical activity categories you see yourself to best belong to (choose one):

- Competitive athlete (participates in physical activity mainly to gain success in competitions)
- Recreational sportsman (participates in physical activity mainly to *improve and develop fitness*)
- Active for fitness (participates in physical activity mainly to *maintain fitness*)
- Active for health (participates in physical activity mainly to *maintain health*)
- Active in non-exercise (aims to maintain some sort of physical activity in daily life)
- Occasionally active (does not pay much attention to physical activity in daily life)
- Sedentary (aims to avoid all kinds of physical activity in daily life)
- In none of the above / Cannot say

2. On average, how often do you play <u>any</u> digital games with the following devices (also other than exergames)?

	Daily	Weekly	Monthly	Less than monthly	Only tried once or twice	Never tried	Cannot say
Game console	○	○	○	○	○	○	○
Computer	○	○	○	○	○	○	○
Smart phone	○	○	○	○	○	○	○
Tablet	○	○	○	○	○	○	○
Other device	○	○	○	○	○	○	○

(In the analysis, all devices were treated equal and the digital gaming frequency of a respondent was based on the most common playing frequency with any device)

III

CAN EXERGAMING PROMOTE PHYSICAL FITNESS AND PHYSICAL ACTIVITY?: A SYSTEMATIC REVIEW OF SYSTEMATIC REVIEWS

by

Tuomas Kari, 2014

International Journal of Gaming and Computer-Mediated Simulations, vol. 6, 59-77

Can Exergaming Promote Physical Fitness and Physical Activity?

A Systematic Review of Systematic Reviews

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ABSTRACT

This systematic review of systematic reviews evaluates the effectiveness of exergaming on physical fitness and physical activity. A systematic literature search was conducted on 10 databases, and 1040 articles were identified. Sixty-eight articles were found potentially relevant and were selected for closer screening. Cross-referencing was conducted to find other potentially relevant articles. The quality of all relevant articles was evaluated using the AMSTAR tool. After all the duplicates were removed and inclusion, exclusion, and quality criteria were implemented, six articles remained for review. The results indicate that exergaming is generally enjoyed and can evoke some benefits for physical fitness and physical activity, but the current evidence does not support the ability of exergaming to increase physical fitness or physical activity levels sufficiently for significant health benefits. This systematic review also revealed several gaps in previous research. Additional high-quality research and systematic reviews concerning exergaming are needed.

Keywords: Active Video Games, Exergames, Exergaming, Physical Activity, Physical Fitness, Systematic Review

INTRODUCTION

The health consequences of physical inactivity as well as the health benefits of physical activity are well established (e.g. Lee et al., 2012; Warburton, Nicol, & Bredin, 2006; World Health Organisation [WHO], 2010, p. 10). Physical inactivity is a serious public health problem. It has been identified as the fourth most significant risk factor for global mortality (WHO, 2010, p. 10), and several studies have presented evidence on the increasing healthcare costs caused by physical inactivity (e.g. Kohl et al., 2012; Lee et al., 2012). Thus, physical inactivity is not just an individual problem but also a societal one, and due to its importance from the perspective of both public health and finance, finding new ways to promote physical activity and prevent physical inactivity is essential.

DOI: 10.4018/ijgcms.2014100105

Changes in society have led to a significant decrease in the level of physical activity of individuals during the past decades. One of the major changes has been the growing popularity of leisure time sedentary activities brought about by new media solutions such as television viewing, computer use, and video gaming (Matthews et al., 2008; Matthews et al., 2012). Sedentary activities have been shown to be a distinct risk factor for several adverse health outcomes among both adults (e.g. Matthews et al., 2012; Thorp, Owen, Neuhaus, & Dunstan, 2011) and children (e.g. Saunders, Chaput, & Tremblay, 2014; Tremblay et al., 2011). At the same time, the popularity of video gaming is on the rise. It has already become one of the most popular entertainment mediums in the world (Maddison et al., 2013), and Gartner, Inc. (2013) estimates that the total market for video games will increase from US$93bn (end of 2013) to US$111bn by 2015. This raises an interesting question about whether video games could be utilised as a medium to promote physical activity.

In recent years, a new form of video gaming that combines exercise and games has emerged. This type of gaming has been called by different terms such as ‘exergaming’, ‘active gaming’, or ‘active video gaming’ (AVG). They all refer to digital gaming that requires physical effort from the player in order to play the game, with the outcome of the game being mainly determined by these physical efforts (Mueller et al., 2011). Exergames are played in all age groups, but it seems that playing is more common among the younger age groups than the older (Kari, Makkonen, Moilanen, & Frank, 2013). The widespread familiarity and allure of video games makes exergaming an interesting research area, for example in terms of promoting a more active and healthier lifestyle (Maddison et al., 2013). Over the past years, researchers have become increasingly interested in exergaming and especially in its effects on physical fitness and physical activity levels.

This article is a systematic review of systematic reviews and meta-analyses of exergaming published in the fields of information systems and healthcare. The objective of this review article is to form a wide range view of the effects that exergaming activities have on physical fitness (PF) and physical activity (PA) levels and also to identify gaps in previous research. More precisely, it aims to answer the following research questions: (1) What levels of exertion are typical for exergaming? (2) Can exergaming contribute to increasing physical activity? (3) Can exergaming be used to increase physical fitness? This article also identifies gaps in previous research and gives recommendations for future studies.

METHODOLOGY

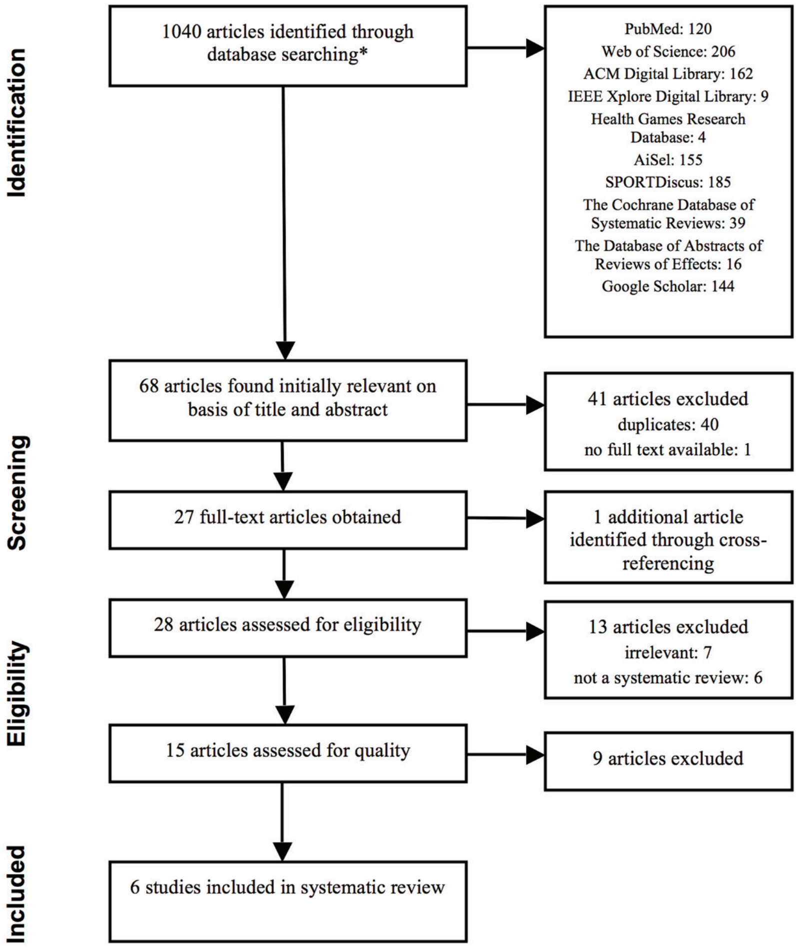
The methodology followed the guidelines given by Smith, Devane, Begley, and Clarke (2011). The research design was determined *a priori*. The research questions, search strategy, and inclusion/exclusion criteria were established before the actual search and review. Flow of information through the different phases of this systematic review is presented in Figure 1, as guided by the PRISMA statement (Liberati et al., 2009; Moher, Liberati, Tetzlaff, & Altman, 2009).

Search Strategy

The search took place in January 2014 and was conducted in the following 10 databases: Thomson Reuters Web of Science, ACM Digital library, IEEE Xplore Digital library, Health Games Research Database, AISeL, SPORTDiscuss, PubMed, The Cochrane Database of Systematic Reviews, The Database of Abstracts of Reviews of Effects, and Google Scholar. The search was repeated in February 2014 to ensure that no relevant articles were left unnoticed. In this second search, no additional articles were revealed.

The following keywords or their different forms were used alone or in combination in the search: ‘exergame’, ‘exergam*’, ‘exertainment’, ‘active video game’, ‘console game’, ‘mobile game’, ‘computer game’, ‘video game’, ‘serious game’, ‘persuasive game’, ‘active

Figure 1. Flow diagram of study selection



video gam*', 'console gam*', 'mobile gam*', 'computer gam*', 'video gam*', 'serious gam*', 'persuasive gam*' and 'physical activit*', 'fitness', 'motor activit*', 'exercis*', 'physical effect*', 'physical*', 'motivation', 'heart rate', 'energy expenditure', 'muscle activity', 'oxygen consumption', 'MVC', 'systematic review', 'review', 'meta-analysis', and 'meta*'. The actual keywords used varied a bit between different databases, depending on how the database handled search operators, but in every case, the keywords used aimed for maximal coverage of the studies under search. At this stage, the articles were searched regardless of publication type. In addition to the conducted database searches, the retrieved reviews were cross-referenced to find other potentially suitable systematic reviews and meta-analyses.

The initial search revealed a total of 1040 articles. Through reading of the titles and abstracts, 68 articles were found to be initially relevant and were selected for closer screening. One potentially relevant article (Hall, Chavarria, Maneeratana, Chaney, & Bernhardt, 2012) had to be excluded, because no full text was available. After removing duplicates, 27 articles remained. Cross-referencing revealed one additional new relevant article. This brought the total number of articles to 28, which dropped down to 15 after all the inclusion and exclusion criteria were introduced and down to six after quality assessment.

Inclusion and Exclusion Criteria

To be included in this review, the study needed to fulfil the following criteria. (a) It had to be a systematic review. (b) Because of the advances in the technology used in exergames, new game types, and novel physical measurement technology, this review only consisted of reviews published during the last four years (01/2010–01/2014). However, these reviews could also include studies from earlier years. (c) Only published peer-reviewed journal and conference publications were included. (d) For feasibility reasons, only reviews in the English language were selected for closer screening. However, this only excluded three reviews in the initial search phase. (e) The main focus of the review was on exergames (not, for example, on eHealth interventions in general) and on PA or PF.

Reviews were excluded if they were found to be either irrelevant (seven studies) (Cushing & Steele, 2010; Hieftje, Edelman, Camenga, & Fiellin, 2013; Ickes, Erwin, & Beighle, 2013; Maitland, Stratton, Foster, Braham, & Rosenberg, 2013; Parrish, Okely, Stanley, & Ridgers, 2013; Primack et al., 2012; Van Camp & Hayes, 2012) or not systematic (six studies) (Best, 2013; Brox, Fernandez-Luque, & Tøllefsen, 2011; Foley & Maddison, 2010; Osorio, Moffat, & Sykes, 2012; Sween et al., 2012; Van Diest, Lamoth, Stegenga, Verkerke, & Postema, 2013). If a review was both irrelevant and not systematic, it was categorised as irrelevant. Irrelevant studies included, for example, those whose main focus was on something other than exergaming and those which focused mainly on rehabilitation, learning, cognitive abilities, or something other than PF or PA. Studies that were low in research design quality, assessed by the AMSTAR tool, were also excluded (nine studies) (Bleakley et al., 2013; Connolly, Boyle, MacArthur, Hainey, & Boyle, 2012; do Carmo, Goncalves, Batalau, & Palmeira, 2013; Guy, Ratzki-Leewing, & Gwadry-Sridhar, 2011; Lamboglia et al., 2013; Peng, Lin, & Crouse, 2011; Rahmani & Boren, 2012; Ruivo, 2014; Taylor, McCormick, Impson, Shawis, & Griffin, 2011).

Quality Assessment of the Reviews

To estimate the research design quality and risk of bias of the reviews, the AMSTAR tool (Shea et al., 2007; Shea et al., 2009) was used. All the articles that were identified as relevant after the implementation of all the inclusion and exclusion criteria were assessed. AMSTAR was chosen because of its reliability (high interobserver agreement of the individual items with mean kappa = 0.70) and construct validity (intraclass correlation coefficients = 0.84) (Shea et al., 2009). AMSTAR is an 11-item instrument for evaluating the methodological quality of systematic reviews. The AMSTAR items are scored as ‘yes’, ‘no’, ‘can’t answer’, or ‘not applicable’. ‘Can’t answer’ is chosen when the item is relevant but not described by the authors, whereas ‘not applicable’ is used when the item is not relevant. Every ‘yes’ answer scores one point for the study. The AMSTAR criteria consist of the following items: 1. ‘Was an “a priori” design provided?’ 2. ‘Was there duplicate study selection and data extraction?’ 3. ‘Was a comprehensive literature search performed?’ 4. ‘Was the status of publication (i.e. grey literature) used as an inclusion criterion?’ 5. ‘Was a list of studies (included and excluded) provided?’ 6. ‘Were the characteristics of the included studies provided?’ 7. ‘Was the scientific quality of the included studies assessed and documented?’ 8. ‘Was the scientific quality of the included studies used appropriately in formulating conclusions?’ 9. ‘Were the methods used to combine the findings of studies appropriate?’ 10. ‘Was the likelihood of publication bias assessed?’ 11. ‘Was the conflict of interest included?’ (Shea et al., 2009).

The studies were rated as being of low, medium, or good quality. The same rating has

Table 1. AMSTAR quality assessment scores of included articles

Reference	AMSTAR Scoring Items 1–11 (Shea et al., 2009)											AMSTAR Score
	1	2	3	4	5	6	7	8	9	10	11	
Barnett et al., 2011	+	?	+	+	+	+	+	+	+	–	–**	9
Biddiss & Irwin, 2010	+	+	+	+	–*	+	+	+	+	–	–**	9
Larsen et al., 2013	+	+	+	–	–*	+	+	+	+	+	–**	9
LeBlanc et al., 2013	+	+	+	+	–*	+	+	+	+	–	–**	9
Lu et al., 2013	+	+	+	+	–*	+	+	+	+	–	–**	9
Peng et al., 2013	+	+	+	+	+	+	+	+	–	–	–**	9

Scoring coded as:
+: Yes, **–**: No, **?**: Can't answer, **–****: yes, but not for included studies = eligible for score point,
–*: yes for included studies, but no list/reference of excluded studies

also been used in several previous studies (e.g. Fleming, Koletsi, Seehra, & Pandis, 2014; Jaspers, Smeulers, Vermeulen, & Peute, 2011; Płaszewski & Bettany-Saltikov, 2014; Prior, Guerin, & Grimmer-Somers, 2008; Seo & Kim, 2012). Item 11, 'Was the conflict of interest included?' differed from Shea et al. (2009) in the respect that a score point was given if the conflict of interest was included for the systematic review itself—not needing to be included for each of the included studies. Only reviews that were scored as good (≥9 AMSTAR score) were included. Studies that were scored as low quality (≤4 AMSTAR score) or medium (5–8 AMSTAR score) were excluded. This was to ensure that possible false conclusions based on low quality research would be avoided (Shea et al., 2007). Also, Smith et al. (2011) point out that the strength of conclusions depends on the quality of included articles. Therefore, it is important that the included articles are of sufficient quality. AMSTAR item scores and total scores of the included articles are presented in Table 1.

Data Extraction and Synthesis

The included reviews were examined twice to authenticate the data extraction. Data extracted from each article included (a) methodological details (e.g. focus, aim, sample characteristics, number of included studies, game types, main outcome measures); (b) key characteristics of the studies included in the reviews (e.g. publication years, number of participants, platforms); (c) key findings pertaining to effects of exergaming on PF and PA and perceptions of exergaming (e.g. perception, adherence, barriers, facilitators); (d) conclusions; (e) reported limitations; and (f) sources of funding. The quality of the included studies was also assessed using the AMSTAR tool (Shea et al., 2007; Shea et al., 2009).

The data extracted from the included reviews was tabulated and summarised for further analysis. The effects of exergaming on physical fitness and physical activity were examined separately in the results section. Results concerning exergaming perceptions were also reported. Because of the target of this systematic review (systematic reviews), the included articles possessed heterogeneity, and therefore, a meta-analysis (pooling of results) was not performed. Instead, a qualitative narrative synthesis was conducted.

RESULTS

The final number of included articles was six. The key characteristics and methodological details of the included articles are presented in

Table 2, and the key findings and conclusions in Table 3. Reported limitations and funding are presented in appendix A. Out of the six articles, two focused mainly on PF and four on both PF and PA. Four articles targeted children and youth, one, children and adults, and one, the elderly. As the majority of video gamers are age 18 or older, e.g. 71% in the USA (Entertainment Software Association [ESA], 2014, p. 3), there is a need for more exergaming research targeting adults and the elderly. All articles were mainly focused on console-based exergaming and none mainly on mobile-based exergaming. This is most probably due to the fact that, as mobile-based exergames are a rather novel concept, so far the majority of studies regarding exergaming have focused on console-based exergames. This demonstrates the need for more research on mobile-based exergaming. The final six systematic reviews and meta-analysis articles had reviewed a total of 145 studies published between 2002 and 2013. The publication years of the included reviews and the studies in them are presented in appendix B. Some studies were reviewed in more than one systematic review. The overlap of studies is presented in appendix C. The number of distinct studies reviewed in the included systematic reviews was 89.

Physical Fitness

The articles presenting the results of the effects of exergaming on PF provide a fairly consistent finding that the most typical level of exertion in exergaming is light-to-moderate for children and youth (Barnett, Cerin, & Baranowski, 2011; Biddiss & Irwin, 2010; LeBlanc et al., 2013; Peng, Crouse, & Lin, 2013), with the average metabolic equivalent (MET) values being just over the moderate threshold of 3 METs (Barnett et al., 2011; Biddiss & Irwin, 2010; Peng et al., 2013). One article (Peng et al., 2013) reported on the exertion level of exergaming among adults, concluding that the typical level is also light-to-moderate among adults, but is lesser among older adults. Biddiss and Irwin (2010) also reported on the percentage increase in energy expenditure and heart rate from resting values. The values varied between game types. The mean percentage (SD) increases were 222% (100%) in energy expenditure and 64% (20%) in heart rate. They found percentage increases in heart rate (difference, −29%; 95% confidence interval, −47 to −11; P=.03) and energy expenditure (difference, −148%; −231% to −66%; P=.001) to be significantly lower for games that require primarily upper body movements compared with those that require lower body movements or those that engage the whole body (Biddiss & Irwin, 2010.) As such, exergaming can provide exertion that surpasses the minimum intensity level recommended by the U.S. Department of Health and Human Services (2008, p. vii). However, the level of exertion seems to be dependent on the ability of the game to provide exertion of adequate intensity (Barnett et al., 2011; Biddiss & Irwin, 2010) and on the player him or herself (Barnett et al., 2011; Biddiss & Irwin, 2010; Peng et al., 2013). Games that require lower body movement are more effective than games requiring only upper body movement, while games that require both are the most effective (Biddiss & Irwin, 2010; Peng et al., 2013). Also, the intensity with which the player chooses to play the game (Barnett et al., 2011), skill level and gaming experience (Barnett et al., 2011; Peng et al., 2013), multiplayer participation (Biddiss & Irwin, 2010), as well as gender, age, and weight (Peng et al., 2013) may all have their impact.

When looking at longer-term effects of exergaming on PF among children and youth, the evidence of beneficial effects is limited. Biddiss and Irwin (2010) reported that exergaming did not result in changes in physiological measures at a statistically significant level. The concluding results in LeBlanc et al. (2013) were similar, as they reported that exergaming interventions in general had no effect on PF, with the evidence for the effect of interventions on cardio-metabolic health indicators being inconclusive. Lu, Kharrazi, Gharghabi, and Thompson (2013) reported, however, that around 40% of the studies they had reviewed observed positive obesity-related outcomes, mostly with overweight or obese children.

Table 2. Key characteristics and methodological details of the included articles

Reference	Focus	Studies	Participants and Data	Game Types	Main Outcome Measures
Barnett et al., 2011	PF + PA Youth	N = 13 (9 PF + 4 PA) 9 laboratory + 4 INT (3 RCT) 2006–2009	PF: N = 13–25 PA: N = 16–60 Age: 6–18 (6+) Weight: not pre-set Sex: both	Not pre-set Upper body, lower body, full body	PF: resting EE, video game EE, (relative) METs PA: play, PA, other outcome, facilitators of maintenance and barriers to maintenance of play
Biddiss & Irwin, 2010	PF + PA Children and youth	N = 18 (12 PF + 6 PA) 12 laboratory + 6 INT (2 RCT) 2002–2010	PF: N = 11–51 PA: N = 12–60 Age: 6–19 (≤21) Weight: not pre-set Sex: both	Mainstream Upper body, lower body, full body	PF: increase in EE & HR from resting values, MET PA: PA promotion, sedentary screen time, dropout rate (in studies)
Larsen et al., 2013	PF Healthy elderly	N = 7 (7 PF) 7 INT (7 RCT) 2011–2012	PF: N = 25–79 Age: N = 82–86 Weight: not pre-set Sex: both	Not pre-set Lower body, full body	PF: aerobic fitness, muscle strength, balance, body composition
LeBlanc et al., 2013	PF + PA Children and youth	N = 52 (52 PF + 22 PA)[a] 20 laboratory + 35 INT (20 RCT) 2006–2012	PF & PA: N = 1-322 Age: 3–17 Weight: not pre-set Sex: both	Not pre-set Lower body, upper body, full body	PF: acute EE, PA: increased PA, decreased sedentary behaviour, change in fitness
Lu et al., 2013	PF Childhood	N = 14 (14 PF) 14 INT (10 RCT) 2005–2013	PF: N = 20–473 Age: 7–18 (≤18) Weight: not pre-set Sex: both	Not pre-set Lower body, upper body, full body	PF: BMI, BMI z-score / percentile / SD-score, waist circumference, waist-to-hip/height ratio, BI analysis
Peng et al., 2013	PF + PA Children and adults	N = 41 (28 PF + 13 PA) 28 laboratory + 13 INT (8 RCT) 2002–2011	PF: N = 8–100 PA: N = 12–60 Age: all age Weight: not pre-set Sex: both	Off-the-shelf & home use Lower body, upper body, full body	PF: MET, BMI, change in sedentary behaviour and physical activity pattern PA: adherence, motivation for play, enjoyment, rating of perceived exertion
PF: physical fitness, PA: physical activity, INT: interventions, RCT: randomised controlled trial, EE: energy expenditure, HR: heart rate, MET: metabolic equivalent, BMI: body mass index, BI: bioelectrical impedance. [a] some had focus on both.					

Peng et al. (2013) concluded that only relying on exergaming for weight loss is not sufficient. LeBlanc et al. (2013) and Peng et al. (2013) added that the typical exertion level of exergaming is not sufficient to meet the guidelines of daily 60-minute moderate-to-vigorous intensity of PA for children.

Focusing on the elderly, Larsen, Schou, Lund, and Langberg (2013) found exergaming to have a positive effect on health. However, the effect was not superior compared to that from traditional exercise. Peng et al. (2013) pointed out that the typical light-to-moderate intensity of exergaming matches the PA recommendations for older adults.

Physical Activity

All four articles focusing on the effects of exergaming on PA present a consistent result, which is that the evidence of exergaming contributing to increased PA is limited or inconclusive (Barnett et al., 2011; Biddiss & Irwin, 2010; LeBlanc et al., 2013; Peng et al., 2013). Regarding children and youth, the reported positive effects of exergaming on PA were short-term (Barnett et al., 2011; Biddiss & Irwin, 2010), and all articles stated that there is little support for exergaming increasing long-term PA (Barnett et al., 2011; Biddiss & Irwin, 2010; LeBlanc et al., 2013; Peng et al., 2013). However, three articles suggested that exergaming has the potential to replace some sedentary behaviour (Biddiss & Irwin, 2010; LeBlanc et al., 2013; Peng et al., 2013). The only article that also focused on PA among adults (Peng et al., 2013) stated that exergaming increased the PA attendance among adults but not among older adults. However, the evidence was limited and should be regarded with caution. As such, it would seem that exergaming may increase PA and decrease sedentary behaviour in the short term but that there is very limited evidence to support the ability of exergaming to increase long-term PA.

Perceptions

Five of the articles also discussed the perceptions of exergaming. In general, children and youth (Biddiss & Irwin, 2010; LeBlanc et al., 2013), adults (Peng et al., 2013), and the elderly (Larsen et al., 2013) were reported to enjoy exergaming. Larsen et al. (2013) also reported beneficial effects on PA motivation among the elderly. Older adults also seem to enjoy lower intensity exergaming more than younger people do (Peng et al., 2013). LeBlanc et al. (2013) and Peng et al. (2013) also reported that exergaming was generally better liked than traditional exercises. Still, four of the five articles reported a decrease in exergaming play over time or during the interventions with children and youth (Barnett et al., 2011; Biddiss & Irwin, 2010; LeBlanc et al., 2013; Peng et al., 2013). Barnett et al. (2013), Biddiss and Irwin (2010), and LeBlanc et al. (2013) all concluded that there is a lack of evidence supporting the long-term use and adherence to exergaming.

Peng et al. (2013) reported on the perceived exertion of exergaming. Children perceived exergaming to be similar to lower intensity activities, while adults perceived exergaming to be similar to activities requiring higher metabolic exertion. Older adults' perception of the exertion level of exergaming was relatively low. When compared to actual measured exertion levels, children found exergaming to be less physically demanding than it actually was (Peng et al., 2013).

Two studies suggested that multiplayer features such as interaction with others or competitive play with peers might increase the participation in and maintenance of exergaming, at least among children and youth (Barnett et al., 2011; Biddiss & Irwin, 2010). These studies also reported on facilitators and barriers to exergaming maintenance. Mentioned facilitators included competition, peer and family support, greater variety of music in a dance exergame (Barnett et al., 2011), enjoyment, and exergaming not being constrained by typical barriers to participation such as lack of transportation, seasonal conditions, or unsafe neighbourhoods

Table 3. Key findings and conclusions of the included articles

Reference	Effects of EG on PF	Effects of EG on PA	EG Perceptions
Barnett et al., 2011	The average intensity level of PA during EG play was approximately 3.2 METs (95% CI: 2.7, 3.7). EG can elicit PA of recommended intensity.	Sustainable EG play has yet to be demonstrated. No strong support for EG enabling engagement in play over periods of time necessary to make a contribution to health.	Most studies reported EG use declined over time. Barriers to maintenance: boredom, technical problems. Facilitators to maintenance: peer and family support, competition.
Biddiss & Irwin, 2010	Variable activity levels during EG play (game type), with mean (SD) percentage increases (from rest) of 222% (100%) in EE and 64% (20%) in heart rate. EG enables light-to-moderate-intensity physical activity.	Home EG play may provide some moderate increase in physical activity or decrease in sedentary screen time. Limited evidence of the long-term efficacy of EG for PA promotion.	Several studies noted a decrease in EG play during the study. Barriers: technical difficulties, changes in living arrangements, spatial, auditory. Facilitators: enjoyment, avoiding typical PA barriers, group play.
Larsen et al., 2013	6/7 studies found a positive effect of EG on the health of the elderly, but not superior when compared to traditional exercise.	–	Support for the beneficial effect of EG on motivation and EG being an enjoyable form of exercise.
LeBlanc et al., 2013	Controlled studies show that EG acutely increases light-to-moderate-intensity PA. The majority of the RCTs reported that an EG intervention had no effect on PF.	No clear findings about if or how EG increases habitual PA or decreases sedentary behaviour. No sufficient evidence to recommend EG as a means of increasing daily PA.	The appeal of EG is high for some children, but there is a lack of evidence suggesting long-term adherence. In general, children seem to enjoy EG.
Lu et al., 2013	Positive outcomes related to obesity were observed in 40% of the studies, all of which targeted overweight or obese children.	All but one study found significant change in proximate measures such as the duration of vigorous PA.	–
Peng et al., 2013	EG capable of providing light-to-moderate-intensity (game type) PA for both children and adults. EE of EG among older adults was found to be lesser. Relying only on EG for weight loss is not realistic.	3/13 studies demonstrated that EG resulted in increased PA. Little support regarding the long-term efficacy of using EG for self-managed PA promotion. Relying only on EG as a PA tool among children is not enough.	EG was better liked than traditional exercises. EG usage was low after the initial period among children. Adults had positive attitude to EG and found EG to be enjoyable. Perceived exertion varied (age).
PF: physical fitness, PA: physical activity, EG: exergaming, EE: energy expenditure, MET: metabolic equivalent.			

(Biddiss & Irwin, 2010). Barriers included boredom, technical problems (Barnett et al., 2011) and difficulties, changes in living arrangements, and auditory nuisance (Biddiss & Irwin, 2010).

CONCLUSION

Evidence from the highest quality systematic reviews indicates that exergaming can provide exertion of the recommended intensity set by the U.S. Department of Health and Human Services (2008, p. vii). The typical levels of exertion for exergaming are light-to-moderate among children and youth as well as among adults, but less among the elderly. The exertion levels vary between different game types (upper body, lower body, full body) and between players, depending for example on demographics, chosen gaming intensity, and skill level. Current evidence does not support long-term benefits for PF. Evidence regarding PA suggests that exergaming might be able to contribute to PA on a short-term basis, but little support is found for long-term PA promotion. Also, the evidence does not support long-term adherence to exergaming, although it was found to be an enjoyable activity.

Implications for Practice

Even though exergaming is generally enjoyed and can evoke some benefits for PF and PA, the current evidence does not support the ability of exergaming to increase the PF or PA levels sufficiently for significant health benefits. Therefore, exergaming cannot be recommended as the only method for PF and PA promotion, and other means of physical activity should be used alongside exergaming for significant PF benefits. However, even if exergaming activity does not provide a sufficient level of physical activity, it can reduce the time spent on sedentary activities such as sitting, which in many studies (e.g. Lee et al., 2012; Matthews et al., 2012) has been identified as significantly increasing the risk of chronic diseases. Thus, exergaming can be recommended as a replacement to traditional video gaming activities that usually take place seated.

Future Research Directions

This article also identified gaps in previous research. The biggest gap would seem to be the lack of research on mobile-based exergaming. Therefore, it is recommended that in the future, more studies should focus on this form of exergaming. There is also a need for more studies including adults and the elderly. In general, long-term effects should also be addressed more frequently. As many of the relevant systematic reviews were of not high quality, future systematic reviews on exergaming should pay attention to conducting high quality research from the outset. These issues demonstrate the need for more research on exergaming.

Strengths and Limitations

Strengths of this systematic review include the systematic review process itself, a methodology based on proven guidelines, and the *a priori* research design. Also, articles were searched from both information systems and healthcare databases for maximal coverage. In addition, the retrieved articles were cross-referenced to find other potentially suitable systematic reviews. All the relevant articles were assessed for quality using the AMSTAR tool, and only articles of good quality were included. This was to ensure that possible false conclusions based on low quality research would be avoided. In addition to answering the research questions, gaps in previous research were also identified.

There are some possible limitations to this research. Even though the search strategy aimed for maximal coverage of suitable studies, it is still possible that not all the relevant articles were found. Also, one potentially relevant article had to be excluded because no full text was available, although it is not certain that the excluded article would have met all the inclusion and quality criteria. Due to the nature of this study (systematic review), some of the limitations of the included articles (reported in appendix A) might also have affected the results of this article. There was also some overlap in the studies included among the systematic reviews (reported in appendix C), which might have had some effect on the results of this systematic review. Finally, as none of the included articles focused on mobile-based exergaming, the results can only be examined with respect to console-based exergaming.

ACKNOWLEDGMENT

The author would like to acknowledge support by Professor Taija Juutinen Finni of the Department of Biology of Physical Activity, University of Jyvaskyla, in receiving general help in evaluating the articles and creating the research design.

This research received no specific grant from any funding agency in the public, commercial, or not-for-profit sectors.

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APPENDIX

Appendix A. Reported limitations and funding of the included systematic reviews

Reference	Reported Limitations	Funding
Barnett et al., 2011	Number and quality of research articles in the area of AVGs. Out-datedness due to rapidly evolving research area. Potential publication bias due to studies reporting positive results having a better chance of being published. Selection bias due to the inability to identify relevant studies not included in the selected search engines. Bias in the assessment of study quality due to information necessary to evaluate the quality of a study being inadequately reported.	Primarily funded by a grant from the National Institute of Diabetes & Digestive & Kidney Diseases (5 U44 DK66724-01). Partially funded with federal funds from the USDA/ARS under Cooperative Agreement No. 58-6250-6001.
Biddiss & Irwin, 2010	Quality of research articles reviewed. Regarding energy expenditure measurements, nonstandardised protocols may have contributed to some of the variations observed among studies. Quantitative interstudy comparisons of activity patterns were not feasible owing to variations in study methods and reporting. The most common risks for bias included unconcealed allocation, lack of blinding (where possible), and selectively reported outcomes.	Study was supported by the Natural Sciences and Research Council of Canada, by the Canadian Institutes of Health Research, and by the Bloorview Kids Foundation.
Larsen et al., 2013	Limited number of studies that met all eligibility criteria. Included studies varied in terms of type of intervention, type of control, outcome measures, and methodological quality. A publication bias may have occurred, as well as language bias. The identified studies are limited to our key word search, which might have been insufficient because the use of terms varies greatly in this new field.	We are grateful for funding from the Department of Public Health, University of Copenhagen.
LeBlanc et al., 2013	Relatively low quality of studies in this field of research. The review included studies that were largely based on what could be deemed ‘‘first generation’’ AVGs.	This study was supported by funds from Active Healthy Kids Canada. The organisation had no role in the design and conduct of the study; the collection, management, analysis and interpretation of the data; or the preparation, review and approval of the manuscript.
Lu et al., 2013	Only English language articles were included. The selected articles may be subject to publication bias for positive findings.	This project was partially funded by the National Cancer Institute (grant 1R21CA158917-01A1; ‘‘The Narrative Impact of Active Video Games on Physical Activity,’’ PI: Amy Shirong Lu, PhD).
Peng et al., 2013	The AVGs in this review included only those available off-the-shelf and are not designed with the purpose to increase physical activity. The sample sizes of all the included studies were very small, limiting adequate power of these research studies. Six of the 13 intervention studies did not provide an adequate design to test for effectiveness of the AVG intervention because of lack of a control group without AVG treatment.	This research was supported by a grant from the Robert Wood Johnson Foundation’s Pioneer Portfolio through its national program, Health Games Research.

Appendix B. Publication years of the studies

Publication Years of Included Systematic Reviews	
2010	1
2011	1
2012	0
2013	4
TOTAL	6
Publication Years of Studies Reviewed In Systematic Reviews	
2002	2
2003	0
2004	0
2005	0
2006	9
2007	16
2008	32
2009	23
2010	25
2011	18
2012	19
2013	1
TOTAL	145

Appendix C. The overlap of studies reviewed in included systematic reviews

REFERENCE (n=89) (1st author, publication year)	Barnett et al., 2011	Biddiss & Irwin, 2010	Larsen et al., 2013	LeBlanc et al., 2013	Lu et al., 2013	Peng et al., 2013	CITED (n=145)
Adamo, 2010				X		X	2
Anderson-Hanley, 2012			X				1
Bailey, 2011				X			1
Baranowski, 2011					X		1
Baranowski, 2012				X			1
Barkley, 2009						X	1
Berg, 2012				X			1
Bethea, 2012				X	X		2
Bonetti, 2010						X	1
Calcaterra, 2012					X		1
Chang, 2011				X			1
Christison, 2012					X		1
Chin A Paw, 2008	X	X		X	X	X	5
Deutsch, 2008				X			1
Dixon, 2010				X			1
Duncan, 2011				X			1
Duncan, 2010				X			1
Epstein, 2007				X			1
Errickson, 2012				X			1
Fawkner, 2010				X		X	2
Fogel, 2010				X		X	2
Franco, 2012			X				1
Gao, 2011				X			1
Gao, 2013					X		1
Getchell, 2012				X			1
Goran, 2012					X		1
Guderian, 2010						X	1
Graf, 2009	X	X		X		X	4
Graves, 2007		X					1
Graves, 2008	X	X		X		X	4
Graves, 2008				X		X	2
Graves, 2010				X		X	2
Graves, 2010				X		X	2
Haddock, 2008	X					X	2
Haddock, 2009		X				X	2

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Appendix C. Continued

REFERENCE (n=89) (1st author, publication year)	Barnett et al., 2011	Biddiss & Irwin, 2010	Larsen et al., 2013	LeBlanc et al., 2013	Lu et al., 2013	Peng et al., 2013	CITED (n=145)
Jannink, 2008				X			1
Jones, 2009				X			1
Lam, 2011				X			1
Lanningham-Foster, 2006	X	X		X		X	4
Lanningham-Foster, 2009	X	X		X		X	4
Leatherdale, 2010		X				X	2
Lyons, 2011						X	1
McDougall, 2008		X				X	2
Maddison, 2007	X	X		X		X	4
Maddison, 2011				X	X		2
Maddison, 2012				X			1
Madsen, 2007	X	X		X	X	X	5
Maloney, 2008	X	X		X	X	X	5
Maloney, 2012				X			1
Mellecker, 2008	X	X		X		X	4
Mellecker, 2010				X			1
Mitre, 2011				X			1
Miyachi, 2010						X	1
Moore, 2009					X		1
Murphy, 2009				X	X		2
Ni Mhurchu, 2008	X	X		X	X	X	5
Owens, 2011				X			1
Paez, 2009		X		X		X	3
Penko, 2010				X		X	2
Perron, 2011				X			1
Pichierri, 2012			X				1
Pluchino, 2012			X				1
Unnithan, 2006	X	X				X	3
Rendon, 2012			X				1
Rhodes, 2009						X	1
Roemmich, 2012				X			1
Rubin, 2010				X			1
Sell, 2008						X	1

continued on following page

Appendix C. Continued

REFERENCE (n=89) (1st author, publication year)	Barnett et al., 2011	Biddiss & Irwin, 2010	Larsen et al., 2013	LeBlanc et al., 2013	Lu et al., 2013	Peng et al., 2013	CITED (n=145)
Shih, 2011				X			1
Shih, 2012				X			1
Siegel, 2009						X	1
Sit, 2010				X			1
Smallwood, 2012				X			1
Straker, 2007	X	X		X		X	4
Stroud, 2010						X	1
Szturm, 2011			X				1
Tan, 2002		X				X	2
Thompson, 2009					X		1
Toulotte, 2012			X				1
Trout, 2006						X	1
Warburton, 2007						X	1
Warburton, 2009						X	1
White, 2010			X				1
White, 2011						X	1
Widman, 2006			X				1
Willems, 2009						X	1
Wollersheim, 2011						X	1
Worley, 2011						X	1
Wuang, 2010			X				1

IV

EXPLAINING THE USAGE INTENTIONS OF EXERGAMES

by

Tuomas Kari & Markus Makkonen, 2014

Proceedings of the 35th International Conference on Information Systems (ICIS 2014),
18 pages

Explaining the Usage Intentions of Exergames

Completed Research Paper

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Abstract

Different kinds of digital gaming concepts that combine exercise and games, commonly referred to as exergames, have become increasingly common in recent years. These games, which can be used because of both hedonic and utilitarian reasons, have also become a subject of growing interest among academic researchers. However, the factors that explain their usage remain vaguely understood. This study aims to find out what kinds of factors explain the intentions to use exergames as part of one's exercise. To do this, we first propose a new theoretical model for explaining the usage intentions of exergames and then empirically test this model by analyzing an online survey sample collected from 271 Finnish console-based exergame owners through structural equation modeling (SEM). We find the model to perform exceptionally well and to propose several interesting and important implications for both the development and marketing of exergames.

Keywords: Usage intentions, exergames, structural equation modeling, online survey

Introduction

During the past decades, developments in information and communication technology (ICT) have had a significant impact on a number of fields related to information systems (IS). One such field is video gaming, where the emergence of new sensor and other technologies has facilitated the design and development of entirely new gaming concepts and resulted in video gaming becoming one of the most popular entertainment mediums in the world (Maddison et al. 2013). One type of gaming that has particularly benefited from technological development is exergaming, which is a type of gaming that combines video gaming and physical exercise by requiring physical effort from the player in order to play the game. This type of gaming has also been referred to as active video gaming or exertainment, but exergaming seems to be the most widely adopted term (Oh and Yang 2010).

In recent years, academic researchers have become increasingly interested in exergaming, with most studies focusing on the physical aspects of the games (e.g., Bethea et al. 2012; Howe et al. 2014; Larsen et al. 2013; Lyons et al. 2011; Maddison et al. 2007; Peng et al. 2011; Penko and Barkley 2010; Scheer et al. 2014; Staiano and Calvert 2011; Whitehead et al. 2010) or on their potential to promote physical activity (e.g., Adamo et al. 2010; Baranowski et al. 2012; Graves et al. 2010; Jenney et al. 2013; LeBlanc et al. 2013; Mhurchu et al. 2008; Peng et al. 2013; Rhodes et al. 2009; Trost et al. 2014; Warburton et al. 2007). However, the findings of many of these studies have been quite mixed. For example, in terms of the potential of exergames to promote physical activity, some studies have found evidence to support this claim (e.g., Bethea et al. 2012; Trost et al. 2014), whereas others have found no such evidence (e.g., Adamo et al. 2010; Scheer et al. 2014) or have been inconclusive (e.g., Baranowski et al. 2014; Peng et al. 2013). All in all, the research on exergaming has also been dominated by a very device-centric perspective focusing on the games and gaming devices themselves in contrast to a more user-centric perspective focusing on the users, user behavior, and issues such as why users actually play the games. This is obviously a severe shortcoming, as the understanding of these latter issues can be considered crucial especially for developers and marketers of exergames in terms of offering users the kinds of games that they really want and thereby advancing their adoption and diffusion. In addition, it can also be considered critical for several other stakeholders, such as the health and well-being industry as well as society at large, in terms of finding new ways to motivate people to engage in more physical activity and fight the problems of sedentary lifestyle, which are becoming more and more prevalent in our present society.

In order to fill the aforementioned research gap concerning users and user behavior in the context of exergaming, our goal in this paper is to find out what kinds of factors explain their intentions to use exergames as part of their exercise. To do this, we follow the hypothetico-deductive research method, with which we first propose a new theoretical model for explaining the usage intentions of exergames and then empirically test this model by analyzing an online survey sample collected from 271 Finnish console-based exergame owners through structural equation modeling (SEM). Finally, we also use the findings concerning the model to draw implications for the development and marketing of exergames. As such, the study can be seen to contain both exploratory and confirmatory elements.

The paper consists of seven sections. Following this introductory section, there will be sections covering the concept of exergaming, the aforementioned theoretical model for explaining the usage intentions of exergames, the methodology and results, the discussion and implications, and the limitations and potential paths of future research.

Exergaming

Exergaming refers to a form of digital gaming that aims to combine video gaming and physical exercise by requiring physical effort from the player in order to play the game, with the outcome of the game being mainly determined by these physical efforts (Mueller et al. 2011a). Alternatively, exergaming can be defined as “experiential activity in which playing exergames or any video games that require physical exertion or movements that are more than sedentary activities and also include strength, balance, and flexibility activities” (Oh and Yang 2010, p. 10). Combining these two conceptualizations, we propose a more comprehensive definition of exergaming and adhere to this definition in this study. We define exergaming as *a form of digital gaming requiring aerobic physical effort – exceeding sedentary activity level and including strength-, balance-, or flexibility-related activity – from the player that determines the outcome of the game.*

Today, there are an increasing number of exergaming options. The three most popular video gaming console lines, namely Sony’s PlayStation, Nintendo’s Wii, and Microsoft’s Xbox, all offer devices and games that make exergaming possible in home settings. Additionally, there are numerous portable devices with different types of sensors, such as portable consoles, mobile phones, and tablets, that provide possibilities for exergaming in different kinds of settings. These types of gaming platforms can also be used in community (Baranowski et al. 2014) and public settings, such as senior centers, medical centers, and fitness centers (Lieberman et al. 2011), as well as in school and work environments (Maddison et al. 2013). In addition to the aforementioned console-based and mobile-based exergames, there are also other types of exergames, such as those available in arcades or embedded into exercise equipment, but the commercially available console-based and mobile-based exergames are the ones that are typically most accessible to users (Chamberlin and Maloney 2013). In this paper, the primary focus is on console-based exergames, as our study found them to be the most popular platform to play these type of games.

Exergaming has the potential to provide both fun and utility for its users, and exergames can be used because of both hedonic and utilitarian reasons (Osorio et al. 2012). That is, the reasons for playing the games may relate to such aspects as entertainment, socializing with other people, or promoting one’s own physical health, well-being, and performance. Without a doubt, one of the greatest benefits that exergaming can offer are related to health (Maddison et al. 2013). Researchers in different fields have begun to study solutions to tackle the problems of sedentary lifestyle, which are becoming more and more prevalent in our present society. One proposed way to do this is to aim at promoting physical activity through the gamification of exercise. Exergaming is one method of gamifying exercise (Mueller et al. 2011b). The allure of video games and their widespread familiarity also adds to the potential of exergaming in promoting a healthier lifestyle (Maddison et al. 2013). However, exergaming also poses some challenges. For example, prior studies (e.g., Lyons et al. 2011; Thin et al. 2013) have suggested that games that require more vigorous physical activity might be perceived as less enjoyable than those that require only lighter physical activity. For these reasons, it is also essential to conduct research on exergaming from a user-centric perspective.

Theoretical Model

Our proposed model for explaining the usage intentions of exergames is based on a model that we have previously proposed to explain the usage intentions of different types of exercise monitoring devices, such as heart rate monitors, pedometers, and route trackers (Makkonen et al. 2012a, 2012b). However, in this study, we extended it to cover also the social aspects of playing games because unlike exercise monitoring devices that are mainly intended for individual use, many exergames have also multiplayer features (Liu et al. 2014; Lyons and Hatkevich 2013). These features make them suitable for purposes such as spending time or keeping in touch with friends and family or otherwise socializing with other people. Both our previously proposed model and the extended model proposed in this paper are intended as very context-specific models, meaning that they are intended to explain user behavior specifically in the exercise technology context. This contrasts with more generic theories and models, such the technology acceptance model (TAM) by Davis (1989) and the unified theory of acceptance and use of technology (UTAUT) by Venkatesh et al. (2003), which are intended to explain the acceptance and use of technology more generally in the information systems context and also in other contexts. Although this context specificity obviously limits the applicability of the models, it can also be considered to offer opportunities for more in-depth understanding of the user behavior within this specific context, which can be considered valuable from both theoretical and practical perspectives.

All in all, the proposed model stems from the synthesis of three distinct theoretical domains: the theory of planned behavior (TPB) by Ajzen (1985, 1991), the innovation diffusion theory (IDT) by Rogers (2003), and the typology of consumer value (TCV) by Holbrook (1996, 1999). TPB, which is an extension of the theory of reasoned action (TRA) by Fishbein and Ajzen (1975, 1980) and one of the most commonly used theories for explaining human behavior, was used as the backbone of the model. A schematic illustration of TPB is presented in Figure 1 (the dashed elements are omitted in this study). In accordance with TPB, we hypothesized that the *intention to use* exergames would be explained by three factors: attitude towards their usage, subjective norm towards their usage, and perceived behavioral control over their usage. Here, *attitude* refers to an individual's positive or negative evaluations of performing a behavior, whereas *subjective norm* refers to an individual's perception of social pressure to perform or not perform it. *Perceived behavioral control*, in turn, refers to an individual's sense of capability, control, and self-efficacy to perform it. Each of these three factors was hypothesized to have a positive effect on usage intention. That is, the more positive the attitude towards usage and the stronger the subjective norm towards and perceived behavioral control over it, the stronger should the usage intention be.

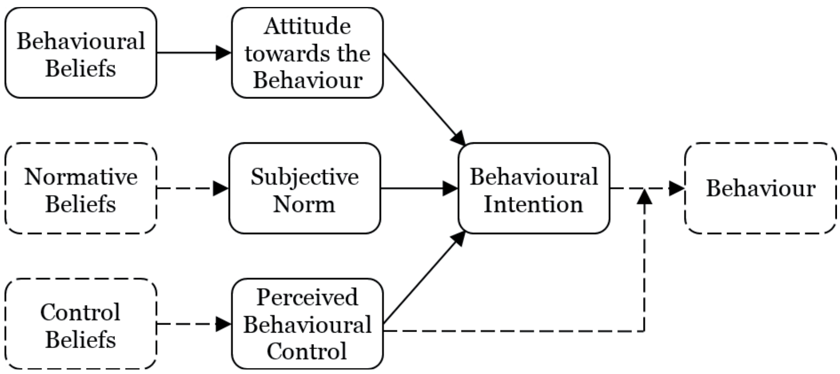

Figure 1. The theory of planned behavior (Ajzen, 1985, 1991)

In addition to explaining usage intention with the three aforementioned factors, we also aimed to explain the attitude towards using exergames with the behavioral beliefs on the outcomes of usage. The same thing could have been done also for subjective norm and perceived behavioral control with the normative and control beliefs, but in this study we decided to concentrate only on attitude, which most prior studies have found to be the most important factor for explaining behavioral intention (Fishbein and Ajzen 2010). In accordance with the decomposed theory of planned behavior (DTPB) by Taylor and Todd (1995), we decomposed the behavioral beliefs into three distinct belief dimensions derived from IDT by Rogers (2003): perceived relative advantage, perceived complexity, and perceived compatibility. In addition to perceived trialability and perceived observability, these factors are typically hypothesized to act as the main determinants of the rate of adoption of innovations. However, we altered the original DTPB in three ways. First, we replaced the concept of perceived complexity, which in IDT is defined as the degree to which an innovation is perceived as relatively difficult to understand and use, with the contrary concept of *perceived ease of use* from TAM, in which it is defined as the degree to which a person believes that using a particular system would be free from effort. To differentiate it from perceived behavioral control, we also defined it more specifically as the freedom from cognitive effort. In accordance with the original TAM, it was hypothesized to have a positive effect on attitude. Second, in addition to *perceived compatibility*, which in IDT is defined as the degree to which an innovation is perceived as consistent with the existing values, past experiences, and needs of potential adopters, we also included in the model the concept of *perceived discomfort*, which we defined more specifically as the degree to which the usage of an innovation is perceived to cause physical discomfort, inconvenience, or distraction to the users. We consider this concept extremely important in the case of exergames, as even a minor degree of perceived discomfort may have a major adverse effect on the playing experience. Thus, contrary to perceived compatibility, perceived discomfort was hypothesized to have a negative effect on attitude.

Third, we replaced the concept of perceived relative advantage, which in IDT is defined as the degree to which an innovation is perceived as being better than the idea it supersedes, with the more comprehensive concept of *perceived value*, which more explicitly incorporates not only the utilitarian but also the hedonic and social perceptions of an innovation. More specifically, we included in the model four types of active value (efficiency, play, status, and ethics) that are defined in TCV by Holbrook (1996, 1999). In addition to these, TCV defines four types of reactive value (excellence, aesthetics, esteem, and spirituality). However, these were omitted from the model because we wanted to concentrate specifically on the value derived from the active usage of these games. A schematic illustration of TCV is presented in Figure 2 (the value dimensions and value types in parentheses are omitted in this study).

		Extrinsic	**Intrinsic**
Self-Oriented	**Active**	Efficiency	Play
	(Reactive)	(Excellence)	(Aesthetics)
Other-Oriented	**Active**	Status	Ethics
	(Reactive)	(Esteem)	(Spirituality)

Figure 2. The typology of consumer value (Holbrook, 1996, 1999)

In the context of exergames, we conceptualized the extrinsic and self-oriented *efficiency value* as value deriving from the perceived ability of exergames to support the more efficient achievement of different types of utilitarian exercise goals. We identified four types of these goals: physical health and well-being goals (e.g., maintaining one's physical health and well-being), physical performance goals (e.g., improving one's endurance, strength, speed, or agility), physical appearance goals (e.g., losing weight, gaining muscles, or toning one's body), and social goals (e.g., spending time or keeping in touch with friends and family or otherwise socializing with other people). These were all included in the model as their own constructs, each of which was hypothesized to have a positive effect on attitude. The goals were derived from the revised motivation for physical activity measure (MPAM-R) scale by Ryan et al. (1997), which defines five motivational dimensions for physical activity: fitness and health, competence and challenge, appearance, social, and enjoyment. Of these, the first four dimensions correspond to the aforementioned health and well-being, performance, appearance, and social goals. In contrast, the fifth dimension, enjoyment, is a hedonic goal and therefore associates better with the intrinsic and self-oriented *play value*, which we conceptualized as value deriving from the perceived ability of exergames to support the achievement of different types of hedonic exercise goals (e.g., making exercise more fun, enjoyable, or pleasurable). Similar to the aforementioned health and well-being, performance, appearance, and social perceptions, these enjoyment perceptions were also hypothesized to have a positive effect on attitude. The extrinsic and other-oriented *status value* was conceptualized as value deriving from the perceived ability of exergames to the give a more positive impression of their users to others. In this context, we defined this more specifically as giving the others a more active impression of oneself. Finally, the intrinsic and other-oriented *ethics value* was conceptualized as value deriving from perceived ability to use exergames to do something for the sake of others. In this context, we defined this more specifically as motivating, inspiring, or encouraging others to exercise in order for them to maintain or improve their health and well-being. Both status and ethics perceptions were hypothesized to have a positive effect on attitude. The entire model is illustrated in Figure 3.

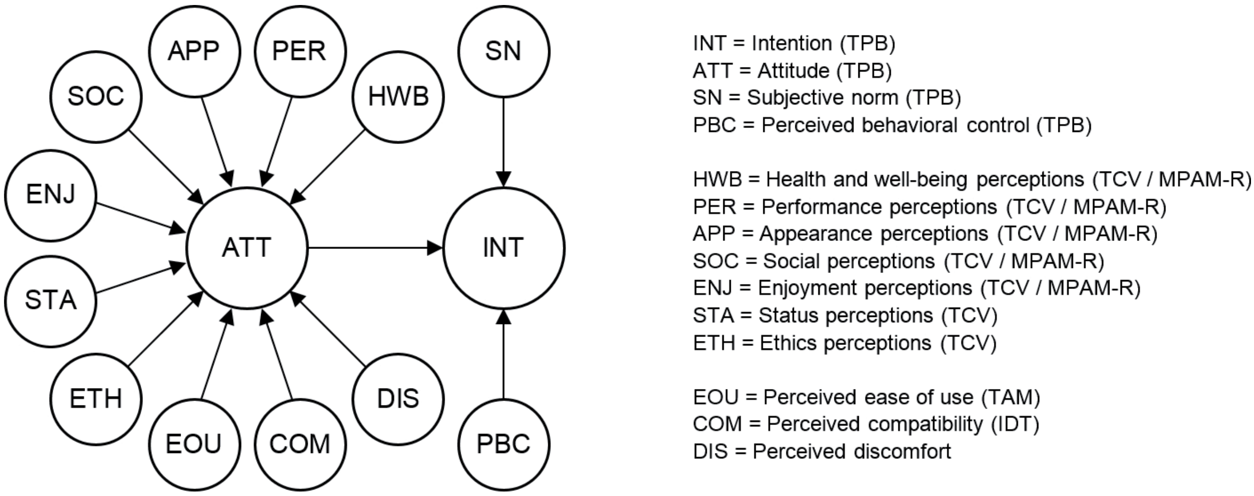

Figure 3. The theoretical model for explaining the usage intentions of exergames

Methodology

To collect the data for testing the theoretical model, an online survey was conducted among Finnish consumers. The survey was created by using the LimeSurvey 2.00+ software, and it was online for about two months from mid-October 2013 to mid-December 2013. During this time, we actively promoted the survey by posting a link to it on several Finnish discussion forums focusing on a variety of topics, sharing the link in social media, and sending several invitation e-mails through the internal communication channels of our university. To raise the response rate, we offered respondents who completed the survey and submitted their e-mail addresses the opportunity to take part in a drawing of six gift cards with a total value of 160 €.

Before the launch of the survey, its questionnaire was pre-tested quantitatively with 87 undergraduate students and qualitatively with five specialists from the IS and sports science fields. Based on their feedback, a few minor modifications were made to the wording and order of items. The final questionnaire consisted of several sections, one of which was used to collect the data for testing the theoretical model. The other sections focused, among other topics, on the exercise habits of the respondents and their usage of exergames. Some of the sections and the items in them were conditional. For example, the data for testing the theoretical model were collected only from the respondents who currently owned console-based exergames. This was to ensure that all the respondents had an approximately equal chance to play the games and at least some experience with them.

Each of the 14 constructs in the theoretical model was operationalized to be measured by three indicators, except for the subjective norm construct, which was operationalized to be measured by four indicators. The measurement models of all the constructs were reflective. The wordings of all 43 indicators, translated from Finnish to English, are reported in Appendix A. The operationalization of the intention, attitude, subjective norm, and perceived behavioral control constructs followed the general guidelines given by Fishbein and Ajzen (2010) as well as the examples given by Taylor and Todd (1995). The attitude construct was measured by asking the respondents to rate their attitude towards the usage of exergames by using a seven-point semantic differential scale consisting of bipolar adjective pairs. As suggested by Fishbein and Ajzen (2010), its indicators were designed to capture both the experiential (ATT2) and instrumental (ATT3) aspects of attitudinal evaluations as well as overall attitude (ATT1). In contrast, the intention, subjective norm, and perceived behavioral control constructs were each measured by asking the respondents to rate statements concerning the usage of exergames by using the traditional seven-point Likert scale consisting of response options ranging from strong disagreement to strong agreement. As suggested by Fishbein and Ajzen (2010), the normative indicators were designed to capture both the descriptive (SN1 and SN2) and the injunctive (SN3 and SN4) aspects, whereas the control indicators were designed to capture both the capacity (PBC1 and PBC2) and autonomy (PBC3 and PBC2) aspects. The time horizon of the intention indicators was set to six months to cover both summertime and wintertime.

The ten behavioral belief constructs were measured similar to the intention, subjective norm, and perceived behavioral control constructs. That is, we asked the respondents to rate statements concerning the outcomes of using exergames by using the traditional seven-point Likert scale consisting of response options ranging from strong disagreement to strong agreement. The operationalization of the health and well-being, performance, appearance, social, and enjoyment perceptions constructs were based on the MPAM-R scale by Ryan et al. (1997), whereas operationalization of the status perceptions construct was based on the study by Sweeney and Soutar (2001). The operationalization of the perceived ease of use and compatibility constructs were based on the studies by Davis (1989) and Karahanna et al. (2006), and they concentrated specifically on cognitive ease of use and on compatibility with existing habits. For the operationalization of the perceived discomfort and ethics perceptions constructs, no suitable examples could be found in prior literature.

The analysis of the collected data was conducted by using the IBM SPSS Statistics 21 and the Mplus 7.11 software. SPSS was mainly used for data preparation and preliminary analysis, whereas Mplus was used for the actual SEM analysis.

Results

We received a total of 1,091 valid responses to our online survey. Of the respondents, 274 (25.1 %) reported that they currently owned console-based exergames, and the responses from these individuals with the exception of three responses with missing values in all the indicator variables were used for testing the theoretical model (N = 271). Of those respondents who did not currently own console-based exergames, 78 (7.1 %) reported that they had previously owned them but did not presently own them, whereas 718 (65.8 %) reported that they had never owned them. In addition, 21 (1.9 %) of the respondents gave no information on their ownership.

Descriptive statistics of the whole sample of 1,091 responses and the aforementioned test sample of 271 responses are presented in Table 1. In terms of their gender distributions, both samples can be characterized as very balanced. However, probably due to the nature of the topic and the way the survey was promoted, the age and income distributions of both samples were tilted toward younger respondents with lower income levels, most of whom were still full-time students in terms of their socioeconomic status. This bias was also reflected by the mean age of the respondents, which was 31.1 years (SD = 12.7 years) in the whole sample and 28.9 years (SD = 9.9 years) in the test sample. However, both samples consisted of a relatively high number of respondents who classified themselves as active players of exergames. They represented 29.2 % of the whole sample, whereas in the test sample, their proportion was as high as 82.7 %.

	Whole sample (N = 1,091)		**Test sample (N = 271)**	
	N	**%**	**N**	**%**
Gender				
Male	506	46.4	122	45.0
Female	585	53.6	149	55.0
Age				
–19 years	133	12.2	56	20.7
20–29 years	498	45.6	99	36.5
30–39 years	225	20.6	68	25.1
40– years	235	21.5	48	17.7
Income				
–14,999 €	498	45.6	112	41.3
15,000–29,999 €	163	14.9	36	13.3
30,000–44,999 €	177	16.2	44	16.2
45,000– €	109	10.0	36	13.3
N/A	144	13.2	43	15.9
Socioeconomic group				
Student	540	49.5	130	48.0
Employed	434	39.8	127	46.9
Unemployed	51	4.7	9	3.3
Pensioner	45	4.1	0	0.0
Other	21	1.9	5	1.8
Playing exergames				
Yes	319	29.2	224	82.7
No	745	68.3	43	15.9
N/A	27	2.5	4	1.5

Table 1. Descriptive statistics of the whole sample and the used sub-sample

Model Estimation

Model estimation was conducted by using the robust maximum likelihood (MLR) estimator, and its results are reported on the left side of Figure 4 (the full covariance matrix on which the model estimation was based is available from the authors upon request). As can be seen, the model performed very well in terms of the proportion of explained variance, as it was able to explain 56.3 % of the total variance in attitude towards using exergames and 67.1 % of the total variance in usage intention. This was in spite of the fact that only two out of the ten behavioral belief constructs, enjoyment perceptions and perceived compatibility, were found to have a statistically significant effect on attitude. The effects of both of these constructs were found to be positive. Attitude, in turn, together with subjective norm and perceived behavioral control, was found to have a statistically significant and positive effect on usage intention.

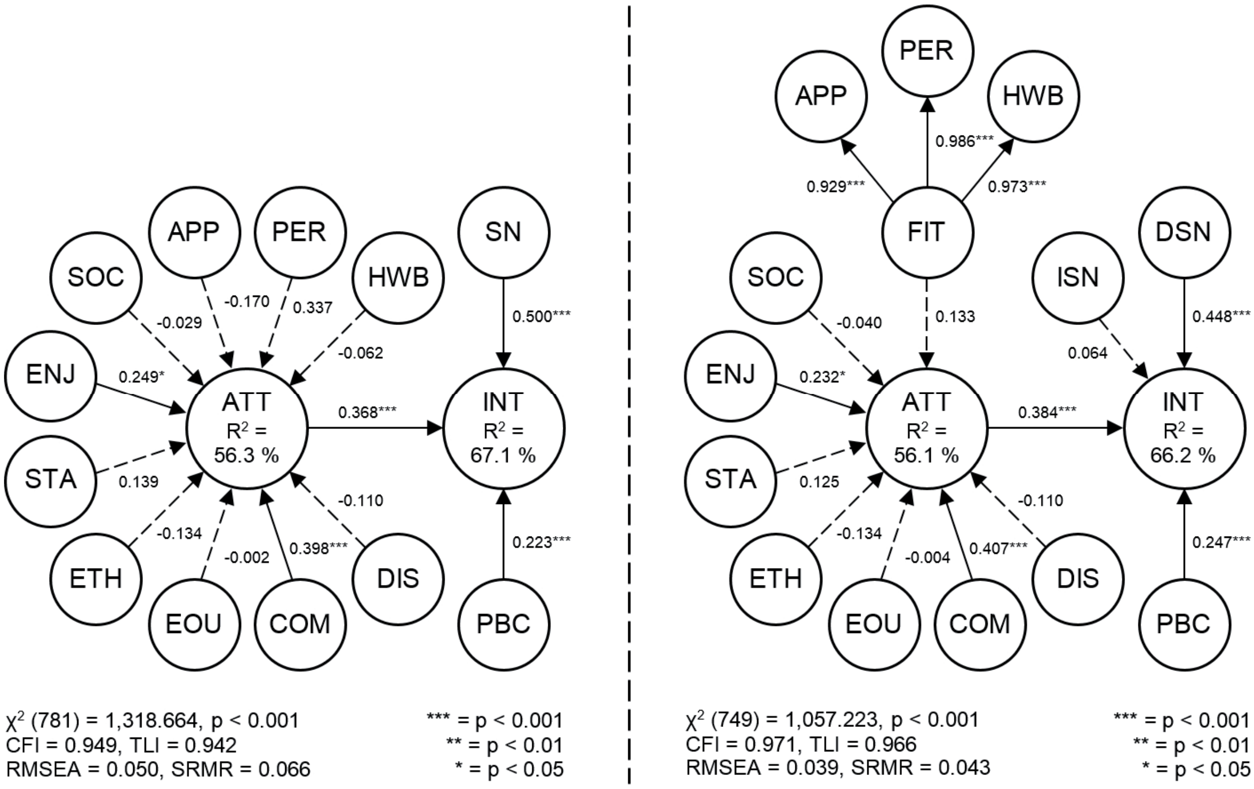

Figure 4. Estimation results before (left) and after (right) the model modifications

In addition to just estimating the model, we also conducted a careful evaluation of its goodness of fit as well as its validity and reliability at both construct and indicator levels. The results of this evaluation are discussed in more detail in the following three sub-sections.

Model Goodness of Fit

The model goodness of fit was evaluated by using the χ^2 test of model fit and four model fit indices: the comparative fit index (CFI), the Tucker-Lewis index (TLI), the root mean square error of approximation (RMSEA), and the standardized root mean square residual (SRMR). Their results and values are presented at the bottom of Figure 4. As can be seen, the results of the χ^2 test suggested rejecting the null hypothesis of the model fitting the data. However, instead of actual misfit, this may have been caused by the tendency of the χ^2 test to underestimate the model fit in the case of large samples or complex models (Bentler and Bonett 1980). In this case, model complexity in particular may have been an issue because the sample size of 271 responses cannot be considered particularly large when estimating a model with this level of complexity. However, also the values of two of the four model fit indices failed to meet the commonly accepted cutoff criteria for a satisfactory model fit (CFI > 0.95, TLI > 0.95, RMSEA < 0.06, and SRMR < 0.08 – Hu and Bentler 1999), further raising the call for model modifications.

Construct Reliabilities and Validities

Construct reliabilities were evaluated by using the composite reliability (CR) coefficient, commonly known also as Dillon-Goldstein's (1984) rho or Jöreskog's rho (e.g., Werts et al. 1974). It is commonly expected that the CR of each construct should be greater than or equal to 0.7 in order for it to exhibit satisfactory reliability (Nunnally and Bernstein 1994). The CR of each model construct is listed in the first column of Table 2. As can be seen, all the constructs met this criterion.

	CR	AVE	INT	ATT	SN	PBC	HWB	PER	APP	SOC	ENJ	STA	ETH	EOU	COM	DIS
INT	0.969	0.913	**0.955**													
ATT	0.901	0.753	0.628	**0.868**												
SN	0.783	0.490	0.697	0.414	**0.700**											
PBC	0.832	0.628	0.409	0.236	0.198	**0.793**										
HWB	0.970	0.914	0.545	0.610	0.511	0.289	**0.956**									
PER	0.961	0.891	0.533	0.593	0.522	0.238	0.957	**0.944**								
APP	0.965	0.902	0.485	0.517	0.514	0.166	0.892	0.926	**0.950**							
SOC	0.896	0.742	0.374	0.251	0.540	0.050	0.380	0.360	0.401	**0.861**						
ENJ	0.957	0.881	0.519	0.642	0.461	0.233	0.774	0.711	0.659	0.438	**0.939**					
STA	0.952	0.868	0.485	0.380	0.605	0.191	0.588	0.590	0.626	0.601	0.486	**0.932**				
ETH	0.948	0.858	0.430	0.293	0.568	0.170	0.519	0.494	0.530	0.705	0.458	0.840	**0.926**			
EOU	0.914	0.780	0.270	0.373	0.133	0.296	0.355	0.323	0.254	0.088	0.360	0.103	0.055	**0.883**		
COM	0.874	0.700	0.613	0.703	0.584	0.275	0.712	0.682	0.620	0.349	0.702	0.473	0.411	0.503	**0.837**	
DIS	0.897	0.745	-0.296	-0.401	-0.166	-0.294	-0.222	-0.180	0.148	-0.131	-0.375	-0.059	-0.088	-0.335	-0.463	**0.863**

Table 2. Construct reliabilities (CR), average variances extracted (AVE), square roots of AVEs (on-diagonal cells), and inter-correlations (off-diagonal cells) of the constructs

The evaluation of construct validities concentrated on the convergent and discriminant validity of the constructs. These were evaluated by using the two criteria suggested by Fornell and Larcker (1981), which are both based on the average variance extracted (AVE) of a construct or, in other words, the average proportion of variance that a construct is able to explain in its indicators. In order to exhibit satisfactory convergent validity, the first criterion requires that each construct should have an AVE greater than or equal to 0.5, meaning that, on average, each construct should be able to explain at least half of the variance in its indicators. The AVE of each model construct is reported in the second column of Table 2. As can be seen, all the constructs met this criterion with the exception of the subjective norm construct. Based on its indicator loadings, this was likely caused by its multidimensional nature in terms of concentrating on both the descriptive dimension (i.e., the normative pressure related to how the important other people are perceived to behave) and the injunctive dimension (i.e., normative pressure related to whether a behavior is thought to be perceived as acceptable or unacceptable by the important other people) of normative beliefs (Fishbein and Ajzen 2010), which in this case seemed not to be closely correlated but to have very different effects on the intention to use exergames.

In order to exhibit satisfactory discriminant validity, the second criterion requires that each construct should have a square root of AVE greater than or equal to its absolute correlation with the other constructs, meaning that, on average, each construct should share at least an equal proportion of variance with its indicators as it shares with the other constructs. The square root of AVE of each model construct (on-diagonal cells) and the correlations between the constructs (off-diagonal cells) are listed in the remaining columns of Table 2. As can be seen, all the constructs met this criterion except for the health and well-being perceptions and performance perceptions constructs, which correlated too strongly with each other. The correlations of the appearance perceptions construct with these two constructs were also very strong, thus questioning the discriminant validity of all these three constructs. The strong correlations of the three constructs were also found to be problematic in terms of multicollinearity, because when using SPSS to run a linear regression analysis with collinearity diagnostics for the construct scores obtained from Mplus, the variance inflation factor (VIF) scores of all three constructs were found to be greater than ten, indicating potential multicollinearity problems (Hair et al. 2009).

Indicator Reliabilities and Validities

Indicator reliabilities and validities were evaluated by using the standardized loadings and residuals of the construct indicators, which are reported in Appendix B. In a case where each indicator loads only on one construct, it is commonly expected that the standardized loading (λ) of each indicator should be statistically significant and greater than or equal to 0.707 (Fornell and Larcker 1981). This is equal to the standardized residual ($1 - \lambda^2$) of each indicator being less than or equal to 0.5, meaning that at least half of the variance in each indicator is explained by the construct on which it loads. As can be seen, all the indicators met this criterion with the exception of the indicators SN3 and SN4 of the subjective norm construct and the indicator PBC3 of the perceived behavioral belief construct. The low loadings of SN3 and SN4 were likely caused by the same multidimensionality issues as discussed above because these two indicators concentrated more on the injunctive dimension, whereas SN1 and SN2 concentrated more on the descriptive dimension of normative beliefs. Similar multidimensionality issues were also likely the cause of the low loadings of PBC3 because this indicator concentrated more on the autonomy dimension (i.e., the perceived degree of control over performing the behavior), whereas PBC1 and PBC2 concentrated more on the capacity dimension (i.e., the perceptions of whether one can, is able to, or is capable of performing the behavior) of control beliefs (Fishbein and Ajzen 2010).

Model Modifications

Because of the issues found, we decided to conduct three modifications to the original model and to re-estimate it. First, in order to address the issues concerning the subjective norm construct, we decided to decompose the construct into two distinct constructs, one concentrating on the descriptive dimension of normative beliefs and the other concentrating on the injunctive dimension of normative beliefs. Of these two new constructs, descriptive subjective norm (DSN) was measured by the indicators SN1 and SN2 of the original subjective norm construct, and injunctive subjective norm (ISN) was measured by the indicators SN3 and SN4 of the original subjective norm construct. Second, in order to address the issues concerning the perceived behavioral control construct, we decided to drop the indicator PBC3 from the model. In this case, the decomposition of the construct into two constructs of which one would have concentrated on the capability dimension and the other would have concentrated on the autonomy dimension of control beliefs was unfortunately not possible due to the number of indicators, so omitting the autonomy dimension altogether was the only real option. Third, as for the issues concerning the health and well-being perceptions, performance perceptions, and appearance perceptions constructs, we considered multiple options, such as dropping one or two of the constructs from the model altogether or composing two or all three of them into one construct. Finally, we decided to introduce a completely new second-order construct called fitness perceptions (FIT), which was measured by the first-order health and well-being perceptions, performance perceptions, and appearance perceptions constructs. This seemed the most justifiable option, as the three original constructs can be seen as dimensions of this more abstract construct capturing the perceived ability of exergames to support the more efficient achievement of the general goal of maintaining or improving one's physical fitness. The more positive this perception is, the more positively this is reflected on the health and well-being, performance, and appearance perceptions as well as on attitude towards playing exergames.

The results of the model re-estimation are presented on the right side of Figure 4. As can be seen, the performance of the modified model in terms of the proportion of explained variance remained more or less the same as that of the original model, as it was able to explain 56.1 % of the total variance in attitude towards using exergames and 66.2 % of the total variance in usage intention. Also the effects between the model constructs remained more or less the same, except for the new descriptive subjective norm and injunctive subjective norm constructs, of which only the former now had a statistically significant and positive effect on usage intention, and the new fitness perceptions construct, which, similar to its indicator constructs in the original model, had a statistically not significant, although a positive, effect on attitude. When the modified model was re-evaluated, it was found to have a slightly better goodness of fit compared to the original model. The results of the χ^2 test still suggested rejecting the null hypothesis of the model fitting the data, but the values of the four model fit indices now all met the commonly accepted cutoff criteria for a satisfactory model fit (CFI > 0.95, TLI > 0.95, RMSEA < 0.06, and SRMR < 0.08 – Hu and Bentler 1999). In terms of construct reliabilities and validities, indicator reliabilities and validities, as well as multicollinearity, no further issues were found. For example, the VIF scores of all the constructs now remained at approximately five or less.

Finally, to evaluate the performance of a pruned model that contained only the constructs that had a statistically significant effect on either attitude or usage intention, we dropped from the modified model all the constructs with statistically not significant effects and re-estimated the model once more. This model, in which attitude was now explained only by enjoyment perceptions and perceived compatibility and in which usage intention was now explained only by attitude, descriptive subjective norm, and perceived behavioral control, was able to explain 54.0 % of the total variance in attitude towards using exergames and 67.2 % of the total variance in usage intention. In other words, the dropped constructs seemed to bring almost no added value to the performance of the model in terms of the proportion of explained variance.

Discussion and Implications

The goal of this study was to contribute to the more user-centric stream of research on exergaming by examining what kinds of factors explain the intentions to use exergames as part of one's exercise. To do this, we first proposed a new theoretical model for explaining the usage intentions of exergames and then empirically tested it by using SEM to analyze an online survey sample collected from 271 Finnish console-based exergame owners. After conducting a few minor model modifications, we found the model to exhibit a satisfactory goodness of fit with the data as well as satisfactory validity and reliability at both construct and indicator levels. In addition, the performance of the model in terms of the proportion of explained variance was found to be exceptionally good, as it was able to explain about two thirds of the total variance in the intention to use exergames and more than half of the total variance in attitude towards their usage. This was despite the fact that only two of the behavioral belief constructs that we originally hypothesized to affect the formation of attitude, enjoyment perceptions and perceived compatibility, were actually found to have a statistically significant effect on it. From a purely confirmatory perspective, this fact can perhaps be considered somewhat disappointing. However, from a more exploratory perspective, an examination of not only which of the effects were found as statistically significant but also which of them were found as statistically not significant, as well as the overall variations in the actual effect sizes, can all be used to draw several interesting implications for both the development and marketing of exergames, the most important ones of which will be discussed in more detail below.

One of the most interesting findings of the study concerns the relatively stronger effect of enjoyment perceptions on attitude towards using exergames in comparison to perceptions of physical fitness promotion, which suggests that attitude towards using exergames is driven more by the hedonic gaming aspects than by the utilitarian exercise aspects of games. That is, people play the games mainly because they are fun, not because they promote one's physical fitness. This finding is similar to the one presented previously by Lin et al. (2012), who studied the players of tennis exergames and also found playing intention to be driven more by perceived enjoyment than by perceived exercise utility. From a practical point of view, the finding can be seen to have very important implications for the marketers of exergames in terms of how they should frame their marketing messages, but also especially for the developers of exergames, who often have to balance between hedonic and utilitarian considerations when designing games. For example, designing the games as very strenuous to play may maximize their effectiveness in terms of physical fitness promotion but may simultaneously kill most of the fun in them. Respectively, designing the games to be less strenuous to play may make them more fun, especially for users who do not care so much about physical activity, but at the same time may make them less useful from an exercise point of view. Of course, it is also possible to design exergames that are perceived as both fun and useful in terms of promoting physical fitness, and this should obviously be the ultimate goal of every exergame developer. However, what we are suggesting here is that if the exergame developers want to minimize their risks in terms of game adoption and usage, they are on the safer side when emphasizing the hedonic aspects and under-emphasizing the utilitarian aspects in the game design, rather than the other way around.

A second interesting finding concerns the strong effect of perceived compatibility on attitude towards using exergames, which suggests that although exergames should be perceived as fun to play, they should also, and even more importantly, be perceived as practical in terms of being compatible with the current exercise habits of their users. That is, instead of requiring significant changes to the ways the users currently exercise, they should rather try to support them as well as possible. To be able to offer such support, exergame developers and marketers obviously first have to find out what the current exercise habits of the users actually are and then figure out ways to support them in the games. However, what makes both of these tasks very challenging is that the exercise habits can obviously vary tremendously between different users. For example, whereas some simply prefer to "hit the gym" once or twice a week, others may do several different kinds of exotic sports daily or even multiple times a day. And if one also takes into consideration daily functional activities, such as walking or cycling to work and back home, the picture becomes even more varied. Thus, it seems a logical implication that exergame developers and marketers should give up on the idea of so-called "mass market exergames" and rather rely on more specialized segmentation strategies in which the games are developed and marketed with very specific target segments in mind right from the outset. These may be, for example, people who are into a specific sport or more generally people who are interested in some more or less similar generic exercise goals, such as maintaining or improving their endurance, strength, speed, or agility. Independent of precisely what these segments are, also in this case the top priority for exergame developers and marketers is to establish a comprehensive understanding of the exercise habits of these segments, for example, through different types of market studies. These may be descriptive studies that aim for a simple description of the exercise habits but also motivational studies that aim to discover the more complex motivational factors behind them.

A third interesting finding concerns the somewhat mixed role of the social environment as a driver of exergame usage. On one hand, the weak effects of social perceptions, status perceptions, and ethics perceptions on attitude towards using exergames suggest that exergame usage is not so much driven by the goals of socializing with other people or influencing them in terms of giving them a more active impression of oneself or inspiring them to exercise more. Similarly, as suggested by the weak effect of injunctive subjective norm on the intention to use exergames, exergame usage is also not really driven by the opinions of other people in terms of the perceived social pressure to play or not to play them. On the other hand, the actual doings of other people are a strong driver for exergame usage, as suggested by the strong effect of descriptive subjective norm on the intention to use exergames. That is, the more common people perceive exergaming to be in their social environment, the more likely they are to play them themselves. For the developers and marketers of exergames, this finding obviously implies that they are likely to benefit from all kinds of strategies that aim to promote the perceived commonness or “trendiness” of exergaming in the society. And the more personal these strategies are, the more effective they are also likely to be. That is, if they can make it seem like exergaming is a common thing in society in general, that is good. To achieve this, one could use, for example, traditional advertising campaigns that portray well-known athletes or other celebrities as enthusiastic players of not just a specific exergame, but exergames in general. However, if they can make it seem like one’s best friend or another person of particular importance is an enthusiastic exergamer, that is even better. One option to achieve this is to use different types of interpersonal marketing campaigns that encourage people to more openly share their exergaming experiences with others. Another option could be to aim at improving the multiplayer features of the games or integrating them more tightly with social networking sites such as Facebook or Twitter so that they would, for example, send automatic status updates to one’s friends every time a user engages in a gaming session or when he or she accomplishes a certain achievement in the game.

A fourth interesting finding concerns the weak effects of perceived ease of use and perceived physical discomfort on attitude towards using exergames, which suggests that the easiness of playing games or the physical inconvenience they cause do not act as particularly strong drivers for their usage. These findings can be considered somewhat surprising when considering the prominent role that perceived ease of use has been proposed to play in the acceptance and use of technology in theories and models such as TAM and UTAUT. There are two things that can perhaps explain these findings. The first explanation relates to the subjective nature of our survey ratings and to the fact that many of our survey respondents rated exergames both very easy to use and causing very little physical inconvenience, most likely thanks to the good user interface design of many modern exergames as well as their utilization of such user-friendly motion sensor technologies as the PlayStation’s EyeToy and Microsoft’s Kinect, which free the user from potentially uncomfortable wearable or hand-held sensors typical to earlier-generation exergaming. Because of this, few of the respondents were likely to have any extreme negative experiences of exergaming in terms of ease and comfort of use. This lack of extreme negative experiences, in turn, may have caused the respondents to “exaggerate” some of the more minor issues that they had experienced while using the games, resulting in bad ratings on ease and comfort of use although these issues really had no major impact on their attitude towards using the games. As a result, the observed effects of perceived ease of use and perceived physical discomfort on attitude obviously weaken. The second explanation relates to the fact that the respondents may have also differed in terms of whether they associated the perceived ease of use and perceived physical discomfort more to the user interfaces of the games or to the games themselves. Those who associated them more to the user interfaces of the games, as was our original intention, were likely to report a more or less linear positive relationship between perceived ease of use and attitude as well as a more or less linear negative relationship between perceived physical discomfort and attitude as hypothesized in our theoretical model. However, those who associated them more to the games themselves may have also reported reverse relationships. After all, games that offer their users a certain level of difficulty are often perceived as more fun to play than those that are too easy, and many users may actually expect the playing of exergames to result in some feelings of physical discomfort because such feelings are often characteristic to physical exercise. Of course, the relationship in this case is not likely to be as linear as in the previous case, meaning that games that are perceived as far too difficult to play and that cause outright physical pain while playing them are likely to result in equivalent negative reactions from users as games that are too easy to play and cause no physical feelings at all while playing them. However, when examined by the means of linear modeling, this difference between respondents may very well have caused two contrary effects of perceived ease of use and perceived physical discomfort on attitude to exist in the same sample, which have canceled each other out or at least weakened each other in terms of total observed effects. If either of these two explanations is valid, then perceived ease of use and perceived physical discomfort might actually have a much larger part to play as the drivers of using exergames than suggested above. And even if this is not the case, one must also keep in mind that perceived behavioral control, and particularly its capacity dimension, was found to have a fairly strong effect on the intention to use exergames, suggesting that the promotion of user perceptions of their own capabilities to use exergames, through enhancing their ease of use for example, should be one of the priorities of exergame developers and marketers.

In conclusion, we hope that the various actors operating in the gaming industry can use the findings and implications presented in this paper to develop even better exergames that meet commercial success, are perceived as both fun and useful by their users, and help society at large to solve some of the prevalent problems related to health and well-being driven by the sedentary lifestyle and the disconcerting decrease in physical activity.

Limitations and Future Research

We consider this study to have three main sets of limitations. The first of them concerns the development of the new theoretical model proposed in this paper, which followed a very deductive approach of synthesizing prior theories on human behavior instead of more inductive approach of, for example, empirically inquiring the owners of exergames which kinds of behavioral beliefs actually affect the formation of their attitude towards using such games. By conducting such inquiries, future research could be able to find completely new constructs that can be used to build even better models for explaining the adoption, usage, and other aspects of user behavior in the context of exergames.

The second set of limitations concerns the actual theoretical model, in which we concentrated only on the behavioral beliefs affecting the formation of attitude towards using exergames instead of the normative and control beliefs, which act as the antecedents to subjective norm and perceived behavioral control. Future research should cover also these beliefs, especially as we found subjective norm, or more accurately descriptive subjective norm, to act as a stronger antecedent to the intention to use exergames than attitude. Respectively, future research may also benefit from extending the model to cover actual usage in addition to only usage intention as well as from the examination of the potential direct effects of behavioral, normative, and control beliefs on usage intention in addition to their indirect effects through attitude, subjective norm, and perceived behavioral control. Although such effects are hypothesized in neither TRA nor TPB, they are typical in theories such as TAM and UTAUT.

The third set of limitations concerns the testing of the theoretical model, which in this study was based on data collected only from Finnish console-based exergame owners. This obviously limits the generalizability of its findings. To address this limitation, future research should concentrate on also collecting data from other countries and on other types of exergames, such as mobile-based exergames, and potentially not only from owners, but also from non-owners of exergames. Future studies could also benefit from controlling the effect of other exercise habits on the usage of exergames, as these could significantly affect the performance of the model. For example, the model may perform very differently in the case of people who do other kinds of physical exercise in comparison to people whose only form of physical exercise is exergaming. In addition, it could be beneficial to examine not only the regression relationships between the model constructs but also the construct scores and construct means, which could be used to examine the absolute and relative strengths of the constructs. Another potential path of future research could be to compare the performance of the context-specific model presented in this paper to the performance of more generic models commonly used to explain the acceptance and use of technology, such as the aforementioned TAM and UTAUT.

Of course, a completely alternative but potentially very fruitful path of future research could be to concentrate more on the actual development of exergames instead of their user behavior as well as on the interconnections between these two domains, such as how the gathered knowledge and understanding of user behavior can be systematically translated into good design decisions when developing the games. For example, if the hedonic issues rise as a major driver of exergame usage, how can the games actually be made more enjoyable or pleasurable from the perspective of the users.

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Appendix A. Indicators

INT1 I intend to use console-based exergames as a part of my exercise in the next six months.

INT2 I plan to use console-based exergames as a part of my exercise in the next six months.

INT3 I am likely to use console-based exergames as a part of my exercise in the next six months.

ATT1 I think that the idea of me using console-based exergames as a part of my exercise in the next six months bad … good.

ATT2 I think that the idea of me using console-based exergames as a part of my exercise in the next six months unpleasant … pleasant.

ATT3 I think that the idea of me using console-based exergames as a part of my exercise in the next six months useless … useful.

SN1 Using console-based exergames as a part of exercise is common among people who are important to me.

SN2 Many people who are important to me use console-based exergames as a part of their exercise.

SN3 Many people who are important to me think that it's a good idea to use console-based exergames as a part of one's exercise.

SN4 Many people who are important to me think that it's a good idea for me to use console-based exergames as a part of my exercise in the next six months.

PBC1 If I wanted to, I would be able to use console-based exergames as a part of my exercise in the next six months.

PBC2 If I wanted to, it would be possible for me to use console-based exergames as a part of my exercise in the next six months.

PBC3 It is up to me whether or not I use console-based exergames as a part of my exercise in the next six months.

I believe that by using console-based exergames as a part of my exercise in the next six months I can or could…

HWB1 …better maintain my physical health.

HWB2 …better maintain my physical ability to function.

HWB3 …better maintain my physical well-being.

PER1 …more efficiently improve my physical capacity.

PER2 …more efficiently improve my physical performances.

PER3 …more efficiently improve my physical capabilities (e.g., endurance, strength, speed, or agility).

APP1 …more efficiently improve my physical appearance.

APP2 …more efficiently shape my body.

APP3 …more efficiently lose weight, gain muscles, or tone my body.

SOC1 …spend more time with friends or family.

SOC2 …socialize more with other people.

SOC3 …better keep in touch with friends or family.

ENJ1 …make my exercise more fun.

ENJ2 …make my exercise more enjoyable.

ENJ3 …make my exercise more pleasant.

STA1 …be perceived as a more active person by other people.

STA2 …give a more active impression of myself to other people.

STA3 …create a more active image for myself.

ETH1 …better motivate other people to exercise.

ETH2 …better inspire other people to exercise.

ETH3 …better encourage other people to exercise.

I believe that using console-based exergames as a part of my exercise in the next six months…

EOU1 …would be clear and comprehensible to me.

EOU2 …would be easy for me to understand.

EOU3 …would be easy for me to learn.

COM1 ...would be compatible with my current exercise habits.

COM2 ...would not run counter to my current exercise habits.

COM3 ...would not require significant changes in my current exercise habits.

DIS1 ...would physically disturb me.

DIS2 ...would feel to me physically uncomfortable.

DIS3 ...would feel to me physically inconvenient.

Appendix B. Indicator Loadings and Residuals

	Loading	Residual
INT1	0.979***	0.042**
INT2	0.961***	0.076***
INT3	0.925***	0.144***
ATT1	0.941***	0.115***
ATT2	0.830***	0.310***
ATT3	0.828***	0.314***
SN1	0.855***	0.268***
SN2	0.842***	0.292***
SN3	0.527***	0.722***
SN4	0.491***	0.758***
PBC1	0.903***	0.185**
PBC2	0.839***	0.296**
PBC3	0.605***	0.634***

	Loading	Residual
HWB1	0.962***	0.075***
HWB2	0.945***	0.108***
HWB3	0.961***	0.077***
PER1	0.974***	0.051***
PER2	0.922***	0.150***
PER3	0.935***	0.125***
APP1	0.966***	0.068***
APP2	0.946***	0.106***
APP3	0.937***	0.123***
SOC1	0.837***	0.299***
SOC2	0.828***	0.315***
SOC3	0.916***	0.162***

	Loading	Residual
ENJ1	0.935***	0.126***
ENJ2	0.940***	0.116***
ENJ3	0.941***	0.114***
STA1	0.924***	0.146***
STA2	0.941***	0.114***
STA3	0.930***	0.136***
ETH1	0.919***	0.156***
ETH2	0.902***	0.186***
ETH3	0.957***	0.085***

	Loading	Residual
EOU1	0.867***	0.249***
EOU2	0.954***	0.089**
EOU3	0.823***	0.323***
COM1	0.907***	0.177***
COM2	0.875***	0.235***
COM3	0.715***	0.489***
DIS1	0.761***	0.420***
DIS2	0.898***	0.193***
DIS3	0.921***	0.152**

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THE HABITS OF PLAYING AND THE REASONS FOR NOT PLAYING EXERGAMES: AGE DIFFERENCES IN FINLAND

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International Journal on WWW/Internet, vol. 11, 30-42

IADIS International Journal on WWW/Internet
Vol. 11, No. 1, pp. 30-42
ISSN: 1645-7641

THE HABITS OF PLAYING AND THE REASONS FOR NOT PLAYING EXERGAMES: AGE DIFFERENCES IN FINLAND

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ABSTRACT

This study examines the habits of playing and the reasons for not playing digital exercise games (i.e., exergames), concentrating especially on the differences between four different age groups of players and non-players. Exergames can be considered an important and interesting research topic as they can be used to motivate people to do more exercise and, consequently, to improve their health and well-being. There are also potentially significant age differences in how these games are perceived. The study is based on analysing an online survey sample of 3,036 Finnish consumers by using contingency tables, the Pearson's !2 tests of independence, and the Cramér's V coefficients. The results of the analysis reveal 11 main reasons for not playing exergames as well as several age differences especially in the reasons for not playing exergames but also in the habits of playing exergames. Based on these results, the exergaming industry still seems to have a long way to go before exergames are perceived interesting enough in terms of the gaming experience and useful enough in terms of their effects on physical fitness. The findings of the study should be taken into account in the design and marketing of exergames.

KEYWORDS

Exergames, habits of playing, reasons for not playing, age diferences.

1. INTRODUCTION

Physical activity has been shown to have a positive impact on people's well-being. According to WHO (2012a), regular physical activity can, among others, reduce the risk of diabetes, cardiovascular diseases, depression, breast cancer, and colon. It can also improve bone and functional health (WHO, 2012b) and have other important health benefits. Physical inactivity, in contrast, is a severe public health problem. It has been identified as the fourth most significant risk factor for global mortality (WHO, 2012b). It has also been found as a major risk factor for chronic diseases, such as type two diabetes and cardiovascular diseases, which are the single most significant causes of death in Western countries (Ermes et al., 2008). According to WHO (2012c), 28 % of men and 34 % of women were insufficiently physically active in 2008. This means that physical inactivity is not just an individual problem but also a societal problem (WHO, 2012b). The reasons for the present levels of physical inactivity are partly related to increased sedentary behaviour at home and work, insufficient participation in physical activities during leisure time, and increased use of passive modes of transport. Also many environmental factors that have resulted from increased urbanisation can promote physical inactivity (WHO, 2012c.).

For example, in the context of Finland, where this study was conducted, the changes in work and everyday life have had a substantial effect on the physical activity and exercise habits. Intentional fitness training started to become more common along with urbanisation and shifts in time use in the 1960s. The field of exercise and sport became more versatile in the 1980s, and since the 1990s, commercialisation and the strengthened role of technology have been dominating trends in this field. Sport and exercise has developed into a social world of its own, where individual preferences have a remarkable impact: nowadays sport and exercise are important forms of self-expression as well.

The physical activity level of Finns has dropped drastically in the past twenty years (Juutinen-Finni, 2010; Koivumäki, 2003). As work as such has changed, increasing number of Finns work sedentary and even leisure time is dominated by sitting: one is often spending time sitting in front of television or computer leading to high amounts of screen time. Researchers have started to talk about a sedentary lifestyle, which is associated with many health risks. The changes in the way of life can be seen in the physical fitness of Finns as well. In numerous extensive population studies, it has been found to decrease substantially (Heiskanen et al., 2011; Santtila et al., 2006; Vaara et al., 2009).

Along with the sedentary lifestyle, intentional sport and exercise have become more common. General guidelines based on epidemiological studies are given on the desired amount of sport and exercise, and the adherence of the Finnish population into these guidelines is examined regularly. From the point of view of these guidelines, less than half of Finns take enough exercise for their health. If the physical activity of Finns remains on its current level and the decrease in the physical fitness continues to follow the perceived trend, the general physical fitness of Finns, the aerobic fitness in particular, will dramatically deteriorate during the coming 25 years (Heiskanen et al., 2011; Hirvensalo et al., 2011; Finnish Sports Federation, 2011). Especially alarming is the situation of 25–39-year-old men, who are the most eager users of different kinds of technological products and gadgets. Therefore, it is of utmost importance to find new measures to motivate people to do more exercise.

Prior research has shown that the usage of sports and wellness technologies can have positive effects on the motivation towards exercise (e.g., Ahtinen et al., 2008; Bravata et al., 2007). In recent years, these technologies have become a part of everyday life for more and more people. A heart rate monitor is already a common training partner for many physically active people, and also the use and demand for many other kinds of technological applications in the field is rapidly increasing. One example of these are digital exercise games or exergames, which require some sort of physical activity from the player in order to play the game. However, the habits of playing these games and the reasons why they either are or are not played remain a relatively unexplored area.

The purpose of this study is to address this shortcoming by examining the habits of playing and the reasons for not playing exergames, concentrating especially on differences between four different age groups of players and non-players. The effect of age on the adoption of innovations is a controversial issue (Rogers, 2003), especially when the adoption is examined on a general or global levels, but also when it is examined on the context of some specific domains, such as exergames. Of the different types of exergames, we concentrate on the games that are based on some sort of digital interface, be it a game console, a computer, or a mobile device, such as a mobile phone or a mobile music player. Because of the lack of prior research, the study is explorative in nature, meaning that habits of playing and the reasons for not playing exergames are examined at a descriptive level without utilising any prior theoretical framework. Methodologically, the examination is based on analysing an online survey sample of 3,036 Finnish consumers by using contingency tables, the Pearson's !2 tests of independence, and the Cramér's V coefficients.

The paper consists of six sections. After the introductory section, in section 2, the concept of exergames is discussed. Section 3 describes the methodology and section 4 presents the results of the study. Section 5 covers the conclusion and discussion of the results. Finally, in section 6, the limitations of the study and future research are considered.

Based on the same data we have also made another research on the same topic, but from a gender point of view. These two studies share parts of the same theoretical background.

2. EXERGAMING

In recent years, different kinds of novel digital concepts that combine exercise and games have emerged. These have been called with different terms, such as exergames, exertainment, active-play video games, and active games (Lieberman et al., 2011). In the end, they all mean the same thing: games that combine exercise and games by requiring the player to do some sort of physical activity in order to play the game. Mueller et al. (2011) define exergames as "a digital game where the outcome of the game is predominantly determined by physical effort". We adhere to this definition.

In general, three types of exergames can be identified. First, there are the screen-based games, which are typically played on game consoles and in home settings. These include the games for Nintendo Wii and Xbox Kinect as well as arcade games. Second, there are the mobile games, which utilise mobile phones, mobile music players, and other types of mobile devices as a platform for the games and typically aim at combining real and virtual world elements through augmented reality. Third, there are the light-sensor-based games, which utilise light-sensors in tracking the player and playing the games. (Lieberman et al., 2011.) Prior research (e.g., Berkovsky et al., 2010) has suggested that exercise and games can be combined without adverse effects on the overall experience and enjoyment of playing, thus demonstrating the potential of exergames in motivating people to do more exercise.

One of the advantages of exergames is that they can promote the physical activity of the players without them having a thorough understanding on physical training (Bogost, 2005). Another advantage is that they can be used in many different settings, such as homes, fitness centres, senior centres, as well as medical and community settings. They can also be adapted to serve people of different ages and with different physical abilities and disabilities, cognitive capabilities, and rehabilitation needs. Respectively, they can be equipped with assessment and coaching features as well as with features for estimating the effects of playing on the physical fitness of the players through, for example, heart rate or energy expenditure (Lieberman et al., 2011).

Prior research has demonstrated that exergames can promote the motivation towards physical activity and exercise (e.g., Berkovsky et al., 2010; Sallis, 2011), have physiological benefits (e.g., Daley, 2009; Maddison et al., 2011), and be utilised as a part of a more extensive aerobic exercise program (Siegel et al., 2009). Of course, this depends on the type of the exergame and the physical exertion level at which the exergame is played. Trout and Christie (2007) also suggest that exergames are able to promote the motivation towards other forms of physical activity and, thus, may act as an incentive for a more active lifestyle.

3. METHODOLOGY

To examine the habits of playing and the reasons for not playing exergames, we conducted an online survey among Finnish consumers. The survey was created by using the LimeSurvey 1.91+ software, and before launching it online, we pre-tested it qualitatively with two postgraduate students and quantitatively with 56 undergraduate students. The survey was online for about one and a half months from 14 December 2011 to 31 January 2012. During this time, we actively promoted the survey link by posting it to several Finnish discussion forums focusing on a variety of topics as well as by sending several invitation e-mails through the internal communication channels of our university and an e-mail list provided by a Finnish company specialising in the testing of exercise devices. To raise the response rate, we also raffled 26 gift cards with a total worth of 750 " among the respondents.

The survey questionnaire consisted of several sections, and the total number of questionnaire items presented to each respondent varied from 46 to 130, depending on their responses. One of the sections was used to survey the respondents on their habits of playing and reasons for not playing exergames. The section began by asking the respondents whether or not they played exergames. Those that stated to be playing, were classified as players and asked descriptive questions about their habits of playing, whereas those that stated not to be playing, were classified as non-players and asked about the reasons for this. Of course, a respondent also had an option to not answer this question at all, in which case no further questions were asked from him or her.

The descriptive questions about the habits of playing exergames that were included in this study were all closed-ended multiple choice questions and concerned the frequency of playing exergames on game consoles, computers, and mobile devices (at least weekly, at least monthly, less frequently than monthly, or has never played), the reason of playing (mainly for fun or mainly for exercise), the setting of playing (mainly in an individual setting or mainly in a group setting), the physical exertion level of playing (light, moderate, or vigorous), and the perceived effects of playing on physical fitness (negative, no effects, or positive). All the questions were optional, meaning that a respondent had the option to skip one or more of them. The reasons for not playing exergames were surveyed by using one open-ended question. Also this question was optional, so a respondent had the option to state one, multiple, or no reasons.

The collected data was analysed by using the IBM SPSS Statistics 19 software. The statistical significance and strength of the dependencies between the responses and gender were analysed through contingency tables, the Pearson's !2 tests of independence, and the

Cramér's V coefficients. These enabled us to examine not only the linear but also the non-linear dependencies, which suited very well the explorative nature of the study.

The stated reasons for not playing exergames were analysed qualitatively by using inductive content analysis (Patton, 1990). First, all the reasons were read several times and preliminary categories were formed. Then, each reason was given a code that classified it under one of the categories. Similar reasons were classified under the same category. If a reason did not fit into any of the formed categories, a new category was formed. After all the reasons were classified, similar categories were combined into broader categories. The categories that consisted of only a few reasons were combined into a category called other reasons.

4. RESULTS

In total, we received 3,036 valid responses to our survey. Of the 2,976 respondents who had stated whether or not they played exergames, 723 (24.3 %) were players and 2,253 (75.7 %) were non-players. Examining those 2,976 who had stated whether or not they play exergames and testing the matter with the Pearson's !2 test of independence, the dependency between age and the playing of exergames was statistically significant at the 0.05 level (!2(3) = 99.873, $p < 0.001$). The playing of exergames was most common in the youngest examined age group of under 25 years (34.3 %), and got less common the older the age group got, with the playing of exergames being second most common in the age group of 25–34 years (27.2 %), third most common in the age group of 35–44 years (23.9 %), and least common in the oldest examined age group of 45 years or over (12.1 %). This is in line with the participation rates in other forms of physical activity and exercise in different age groups among Finnish adults aged 15–64, as they have been found to decrease with age (Finnish Sports Federation, 2011). It is also in line with the playing of digital games in general among Finnish population, as it has been found to be most popular among the youngest age groups and to decrease with age (Karvinen & Mäyrä, 2011).

Table 1. Descriptive statistics of the whole sample and the two sub-samples

Variable		All % (N = 3,036)	Players % (N = 723)	Non-players % (N = 2,253)
Gender	Male	35.6	32.6	36.6
	Female	64.4	67.4	63.4
Age	–24 years	22.2	30.7	18.9
	25–34 years	32.0	36.1	31.0
	35–44 years	21.0	20.9	21.3
	45– years	24.8	12.3	28.8
Yearly income	–14,999 €	34.1	39.2	31.9
	15,000–29,999 €	25.1	21.8	26.3
	30,000–44,999 €	25.5	24.9	25.9
	45,000– €	15.3	14.1	15.9
	N/A (N)	375	77	281
Socioeconomic group	Student	25.3	31.5	23.1
	Employed	59.2	56.7	60.7
	Unemployed	6.9	6.4	6.9
	Pensioner	4.0	1.2	4.7
	Other	4.6	4.1	4.6

Descriptive statistics of the entire sample as well as the sub-samples of players and non-players are presented in Table 1. Overall, the gender, age, and income distributions of the entire sample correspondent very well the gender and age distributions of the Finnish Internet population as well as the income distribution of the Finnish income recipients in 2010 (Statistics Finland, 2012). Women and the youngest age group were slightly overrepresented, whereas men and the two oldest age groups were slightly underrepresented. However, there were no indications of severe non-response bias in terms of the three variables. The entire sample can also be characterised very heterogeneous in terms of the socioeconomic group of the respondents.

In the next two subsections, the habits of playing exergames among the players and the reasons for not playing exergames among the non-players are examined in more detail.

4.1 Habits of Playing Exergames

The responses to the seven descriptive questions about the habits of playing exergames are summarised in Table 2, first for all the players and then for the different age groups. Table 3 summarises the results of the Pearson's !2 tests of independence that were used to examine the statistical significance and strength of the dependencies between age and the responses.

In terms of the devices of playing, the responses suggest that exergames are most frequently played on game consoles and relatively infrequently on computers and mobile devices. Of the players who responded these questions, 312 (43.2 %) stated that they were playing exergames on game consoles at least monthly, 49 (6.8 %) stated that they were playing them on computers at least monthly, and 23 (3.2 %) stated that they were playing them on mobile devices at least monthly. Age was found to have no statistically significant dependency with the playing on game consoles (!2(9) = 11.150, p = 0.266) nor with the playing on computers (!2(9) = 14.338, p = 0.111), but it was found to have a statistically significant dependency with the playing on mobile devices (!2(9) = 19.681, p = 0.020, V =

0.097). In the case of mobile devices, the respondents belonging to the youngest age group were found to be more frequent players than others.

In terms of the reason of playing, the responses suggest that exergames are played mostly for fun. Of the 706 players who responded this question, 602 (85.3 %) stated that they were playing exergames mainly for fun relted reasons and 104 (14.7 %) stated that they were playing exergames mainly for exercise related reasons. Age was found to have no statistically significant dependency with the reason of playing (!2(3) = 5.232, p = 0.156).

Table 2. The habits of playing exergames among the players

		All % (N = 723)	–24 yrs. % (N = 222)	25–34 yrs. % (N = 261)	35–44 yrs. % (N = 151)	45– yrs. % (N = 89)
Playing on game consoles	At least weekly	16.9	20.5	15.8	16.6	16.9
	At least monthly	26.6	25.0	26.3	29.8	26.6
	Less than monthly	54.4	53.2	56.4	51.7	54.4
	Has never played	2.1	1.4	1.5	2.0	2.1
	N/A (N)	6	2	2	0	2
Playing on computers	At least weekly	3.0	3.8	2.3	0.7	7.1
	At least monthly	4.0	5.2	3.5	3.4	3.5
	Less than monthly	21.7	26.3	19.5	19.7	20.0
	Has never played	71.3	64.8	74.6	76.2	69.4
	N/A (N)	22	9	5	4	4
Playing on mobile devices	At least weekly	1.6	4.2	0.0	1.4	0.0
	At least monthly	1.7	2.8	1.2	1.4	1.2
	Less than monthly	11.9	12.3	9.9	14.2	12.9
	Has never played	84.8	80.7	88.9	83.1	85.9
	N/A (N)	26	10	9	3	4
Reasons of playing	Fun	85.3	83.4	84.9	90.7	81.4
	Exercise	14.7	16.6	15.1	9.3	18.6
	N/A (N)	17	5	9	0	3
Setting of playing	Individual	22.1	25.0	22.4	16.0	25.0
	Group	77.9	75.0	77.6	84.0	75.0
	N/A (N)	14	6	6	1	1
Exertion of playing	Light	34.3	30.7	34.8	35.1	40.7
	Moderate	61.1	65.1	60.0	60.1	55.8
	Vigorous	4.6	4.2	5.2	4.7	3.5
	N/A (N)	27	10	11	3	3
Effects of playing	Negative	0.6	1.0	0.0	0.7	1.3
	No effects	81.5	79.2	80.8	87.0	80.0
	Positive	17.9	19.8	19.2	12.3	18.8
	N/A (N)	74	25	27	13	9

Table 3. Age dependencies in the habits of playing exergames among the players

	N	χ^2	df	p	V
Playing on game consoles	717	11.150	9	0.266	0.072
Playing on computers	701	14.338	9	0.111	0.083
Playing on mobile devices	697	19.681	9	**0.020**	**0.097**
Reasons of playing	706	5.232	3	0.156	0.086
Setting of playing	709	10.815	6	0.094	0.087
Exertion of playing	696	3.401	6	0.757	0.049
Effects of playing	649	6.235	6	0.397	0.069

In terms of the setting of playing, the responses suggest that exergames are played mainly in a group setting. Of the 709 players who responded this question, 552 (77.9 %) stated that they were playing exergames mainly in a group setting and 157 (22.1 %) stated they were playing exergames mainly in an individual setting. Age was found to have no statistically significant dependency with the setting of playing (!2(6) = 10.815, p = 0.094).

In terms of the physical exertion of playing, the responses suggest that exergames are played mainly at moderate or light exertion levels. Of the 696 players who responded this question, 425 (61.1 %) stated to be playing mainly at a moderate level, 239 (34.3 %) at a light level, and only 32 (4.6 %) at a vigorous level. Age was found to have no statistically significant dependency with the exertion of playing (!2(6) = 3.401, p = 0.757). According to Finnish Sports Federation (2011), of those Finnish adults aged 19–65 who participate in physical activity, 62 % do so at a moderate level, 16 % at a light level, and 22 % at a vigorous level. These numbers include all forms of physical activity and exercise, not just exergames. When compared, we can see that the habit of playing exergames at a moderate level exertion is in correspondence with the exertion levels of other forms of physical activity. However, other forms of physical activity are done substantially more at a vigorous level, and exergames are played substantially more at a light level.

In terms of the perceived effects of playing, the responses suggest that the playing of exergames is not perceived as having significant effects on physical fitness. Of the 649 players who responded this question, 529 (81.5 %) stated to have perceived no effects, 116 (17.9 %) stated to have perceived positive effects, and 4 (0.6 %) stated to have perceived negative effects. Age was found to have no statistically significant dependency with the effects of playing (!2(6) = 6.235, p = 0.397).

4.2 Reasons for not Playing Exergames

Of the 2,253 non-players, 1,855 (82.3 %) stated one or multiple reasons for not playing exergames. Most (73.0 %) stated just one reason, but some stated two (22.6 %), three (4.3 %), or four (0.1 %) reasons. The total number of stated reasons was 2,438. By classifying these into broader categories, 11 main reasons for not playing exergames were identified. These were: no interest, prefers other forms of exercise, ownership, no money, not useful enough, not a gamer, no time, not familiar, home restrictions, personal restrictions, and other reasons. Examples of the stated reasons that were classified into each category, translated from Finnish to English, are presented in Table 4.

Table 4. The reasons for not playing exergames and examples of the stated reasons

Reason for not playing	Examples of stated reasons
No interest	Not interested, does not motivate, do not like, do not care
Prefers other forms of exercise	Prefers exercising outside / in a group / other forms of exercise
Ownership	Does not own, has not bought
No money	The price, too expensive, can not afford
Not useful enough	Does not perceive useful, not demanding enough physically, no need
Not a gamer	Does not play any digital games, never played digital games
No time	Lack of time, not enough time, no free time for exergaming
Not familiar	Not familiar, has not even heard, unknown
Home restrictions	No space for exergaming / devices, neighbours
Personal restrictions	Age (too old), crippled, weight, physical / bodily restrictions
Other reasons	Too much screen time as it is, kids, other

The number and percentage of the non-players that stated the above-mentioned 11 reasons as their reason for not playing exergames are presented in Table 5, first for all the non-players and then for different age groups of non-players. Table 6 summarises the results of the Pearson's !2 tests of independence that were used to examine the statistical significance and strength of their dependencies between age and the statement of the reasons.

Table 5. The reasons for not playing exergames among the non-players

	All % (N = 2,253)	–24 yrs. % (N = 425)	25–34 yrs. % (N = 698)	35–44 yrs. % (N = 481)	45– yrs. % (N = 649)
No interest	23.7	16.0	21.1	26.0	29.7
Prefers other forms of exercise	21.7	18.1	26.4	23.1	18.2
Ownership	18.2	19.8	17.8	19.5	16.5
No money	12.4	24.5	16.0	5.6	5.5
Not useful enough	12.0	15.8	14.9	7.1	10.2
Not a gamer	7.2	4.0	9.5	8.1	6.3
No time	5.7	4.2	6.4	8.1	4.0
Not familiar	2.8	1.9	2.3	1.5	4.9
Home restrictions	2.2	1.4	4.0	1.7	1.2
Personal restrictions	1.2	0.0	0.7	0.6	2.8
Other reasons	1.2	0.7	1.6	0.8	1.2

Table 6. Age dependencies in the reasons for not playing exergames among the non-players

	N	χ^2	df	p	V
No interest	2,253	31.138	3	**< 0.001**	**0.118**
Prefers other forms of exercise	2,253	17.368	3	**0.001**	**0.088**
Ownership	2,253	2.651	3	0.449	0.034
No money	2,253	114.132	3	**< 0.001**	**0.225**
Not useful enough	2,253	24.347	3	**< 0.001**	**0.104**
Not a gamer	2,253	13.116	3	**0.004**	**0.076**
No time	2,253	11.107	3	**0.011**	**0.070**
Not familiar	2,253	16.018	3	**0.001**	**0.084**
Home restrictions	2,253	15.205	3	**0.002**	**0.082**
Personal restrictions	2,253	22.242	3	**< 0.001**	**0.099**
Other reasons	2,253	2.311	3	0.510	0.032

As can be seen, the five most significant reasons for not playing exergames were the no interest (stated by 23.7 % of all the non-players), prefers other forms of exercise (21.7 %), ownership (18.2 %), no money (12.4 %), and not useful enough (12.0 %). Out of the 11 reasons, 9 reasons had a statistically significant dependency with age. The strongest dependency (V = 0.225) was in the reason no money, which was stated by 24.5 % of the non-players aged under 25 years, 16.0 % of the non-players aged at 25–34 years, 5.6 % of the non-players aged at 35–44 years, and 5.5 % of the non-players aged 45 years or over. The second strongest dependency (V = 0.118) was in the reason no interest, which was stated by 16.0 % of the non¬players aged under 25 years, 21.1 % of the non-players aged at 25–34 years, 26.0 % of the non-players aged at 35–44 years, and 29.7 % of the non-players aged 45 years or over. The third strongest dependency (V = 0.104) was in the reason not useful enough, which was stated by 15.8 % of the non-players aged under 25 years, 14.9 % of the non-players aged at 25–34 years, 7.1 % of the non-players aged at 35–44 years, and 10.2 % of the non-players aged 45 years or over. The fourth strongest dependency (V = 0.099) was in the reason personal restrictions, which was stated by 0.0 % of the non-players aged under 25 years, 0.7 % of the non-players aged at 25–34 years, 0.6 % of the non-players aged at 35–44 years, and 2.8 % of the non-players aged 45 years or over. The fifth strongest dependency (V = 0.088) was in the reason prefers other forms of exercise, which was stated by 18.1 % of the non-players aged under 25 years, 26.4 % of the non-players aged at 25–34 years, 23.1 % of the non-players aged at 35–44 years, and 18.2 % of the non-players aged 45 years or over. The sixth strongest dependency (V = 0.084) was in the reason not familiar, which was stated by 1.9 % of the non-players aged under 25 years, 2.3 % of the non-players aged at 25–34 years, 1.5 % of the non-players aged at 35–44 years, and 4.9 % of the non-players aged years 45 or over. The seventh strongest dependency (V = 0.082) was in the reason home restrictions, which was stated by 1.4 % of the non-players aged under 25 years, 4.0 % of the non-players aged at 25–34 years, 1.7 % of the non-players aged at 35–44 years, and 1.2 % of the non-players aged 45 years or over. The eighth strongest dependency (V = 0.076) was in the reason not a gamer, which was stated by 4.0 % of the non-players aged under 25 years, 9.5 % of the non-players aged at 25–34 years, 8.1 % of the non-players aged at 35–44 years, and 6.3 % of the non-players aged 45 years or over. Finally, the ninth strongest dependency (V = 0.070) was in the reason no time, which was stated by 4.2 % of the non-players aged under 25 years, 6.4 % of the non-players aged at 25–34 years, 8.1 % of the non-players aged at 35–44 years, and 4.0 % of the non-players aged 45 years or over. In the case of remaining two reasons, ownership (stated by 18.2 % of all the non-players) and other reasons (1.2 %), there was no statistically significant dependency with age.

5. CONCLUSION

The study examined the habits of playing and the reasons for not playing exergames, concentrating especially on age differences between four different age groups of players and non-players. In terms of the habits of playing exergames, the results suggest that by far the most common platform for playing exergames are game consoles, and only a few play them on computers or mobile devices. This is not surprising, considering that the majority of exergames are designed and released only for game consoles. However, at the same time, it also highlights the market potential of the other platforms, particularly the mobile devices, in which the penetration rates are still very low. The results also suggest that exergames are mainly played for fun and in a group setting. Therefore, when designing the games, it is important to make them as entertaining as possible and, if reasonable, to include multiplayer features to them.

In terms of the age differences in the habits of playing exergames, the results suggest that playing of exergames is more common the younger the person is and that the commonness decreases with age. When examining the frequency of playing with different devices, age was found to have no dependency with playing on game consoles or computers, but on mobile devices the people in the youngest age group were found to be more frequent players than those in the other age groups. There seems to be relatively small differences in the reasons for playing exergames between different age groups as age was found to have no dependency with the reasons, setting, exertion, or the effects of playing.

In terms of the reasons of not playing exergames, the results suggest that the most significant reason for not playing exergames was the lack of interest towards them. The second most significant reason was that a person prefers other forms of exercise over exergames. The lack of ownership was the third most significant reason. However, the significance of different reasons was found to vary between different age groups. In the youngest age group of under 25 years, the three most significant reasons were 1) no money, 2) ownership, and 3) prefers other forms of exercise. In the age group of 25–34 years, the three most significant reasons were 1) prefers other forms of exercise, 2) no interest, and 3) ownership. In the two oldest age groups of 35– 44 years and 45 years or over, the three most significant reasons were 1) no interest, 2) prefers other forms of exercise, and 3) ownership. As can be seen, the reasons prefers other forms of exercise and ownership were among the three most significant reasons in each of the age groups, and, apart from the youngest age group, the reason no interest also. In the youngest age group, the reason no money was the most significant one. The most significant differences between age groups were in the reasons no money and no interest. No money was more significant the younger the age group was. The main explanation for this lies most probably in the fact that according to Statistics Finland (2012), in Finland, the degree of low income is highest in the age group of under 25 years. On the contrary, the reason no interest was more significant the older the age group was. Thus, when marketing exergames, taking marketing activities aimed also at older age groups could perhaps wake more interest towards exergames among these age groups. One such marketing activity could be to use older and regular people in the commercials instead of athletes. Marketing activities aimed at older age groups could also be beneficial because in them the reason no money plays a less significant role.

Based on these results, it seems that the exergaming industry still has a long way to go before exergames are perceived interesting enough in terms of the gaming experience and useful enough in terms of their effects on physical fitness. Therefore, it is critical that the exergaming industry concentrates on addressing these issues both in the game design and marketing of exergames. Ways that might aid in addressing these issues could be to design exergames that are more physically demanding, as this could result in them being perceived as more useful and, at the same time, also as more interesting. But they should not be designed physically too demanding as this might result in the games not being perceived fun enough. It might also be worthy to bring out the potential physical benefits of playing exergames in their marketing. Overall, finding the equilibrium between the hedonic and utilitarian aspects of playing exergames and delivering this message to potential customers seem to be the main challenges facing the exergame designers and the exergaming industry today and most probably also in the future.

6. LIMITATIONS AND FUTURE RESEARCH

In terms of the habits of playing exergames, the main limitations of this study relate to the operationalisation of some of the surveyed concepts, such as the reason, setting, exertion, and effects of playing, in a relatively simplistic manner, in which they were measured with only one question. This was due to the explorative nature of the study. However, future studies may benefit from more rigorous operationalisations in which the concepts are measured with multiple questions so that the reliability and validity of the measures can be evaluated. All the questions also concentrated on subjective rather than objective measures of the concepts (e.g., perceived exertion of playing and perceived effects of playing). In this study, we also did not examine the relationships between the concepts. In terms of the reasons for not playing, the main limitation of the study relates to the usage of an online survey to collect the data, which obviously prevented us from asking any follow-up questions related to the reasons and may have caused some of the respondents to state the reasons in a rather simplistic manner or even leave some of the reasons unstated. Thus, future studies may benefit from the usage of other methods, such as personal or group interviews, to collect the data. Many of the reasons were also very closely related to each other, perhaps even through causal relations (e.g., some people may not be interested in exergames because they do not perceive them as useful enough). However, these relationships between the reasons were not examined in this study.

ACKNOWLEDGEMENT

The authors wish to acknowledge the Tourism and Leisure Services Programme of Tekes, the Finnish Funding Agency for Technology and Innovation, and the companies participating in the Sedospo project for their funding of this study.

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VI

THE HABITS OF PLAYING AND THE REASONS FOR NOT PLAYING EXERGAMES: GENDER DIFFERENCES IN FINLAND

by

Tuomas Kari, Markus Makkonen, Panu Moilanen & Lauri Frank, 2012

Proceedings of the 25th Bled eConference "eDependability: Reliable and Trustworthy eStructures, eProcesses, eOperations and eServices for the Future", Research Volume, pp. 512-526

25th Bled eConference
eDependability:
Reliable and Trustworthy eStructures, eProcesses, eOperations
and eServices for the Future
June 17, 2012 – June 20, 2012; Bled, Slovenia

The Habits of Playing and the Reasons for Not Playing Exergames: *Gender Differences in Finland*

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Abstract

This study examines the habits of playing and the reasons for not playing digital exercise games (i.e., exergames), concentrating particularly on the gender differences between the male and female players and non-players. Exergames can be considered an important and interesting research topic as they can be used to motivate people to do more exercise and, consequently, to improve their health and well-being. The study is based on analysing an online survey sample of 3,036 Finnish consumers through contingency tables, the Pearson's χ^2 tests of independence, and the Cramér's V coefficients. The results of the analysis reveal 11 main reasons for not playing exergames as well as several gender differences both in the habits of playing and in the reasons for not playing exergames. Based on these results, exergames still seem to have a long way to go before they are perceived as interesting enough in terms of the game experience as well as useful enough in terms of their effects on physical fitness.

Keywords: Exergames, habits of playing, reasons for not playing, gender differences

1 Introduction

Physical activity has been shown to have a positive impact on people's well-being. According to WHO (2012a), regular physical activity can, among others, reduce the risk of diabetes, cardiovascular diseases, depression, breast cancer, and colon. It can also improve bone and functional health (WHO, 2012b) and have other important health benefits. Physical inactivity, in contrast, is a severe public health problem. It has been identified as the fourth most significant risk factor for global mortality (WHO, 2012b). It has also been found as a major risk factor for chronic diseases, such as type two diabetes and cardiovascular diseases, which are the single most significant causes of death in Western countries (Ermes et al., 2008). According to WHO (2012c), 28 % of men and 34 % of women were insufficiently physically active in 2008. This means that physical inactivity is not just an individual problem but also a societal problem (WHO, 2012b). The reasons for the present levels of physical inactivity are partly related to increased sedentary behaviour at home and work, insufficient participation in physical activities during leisure time, and increased use of passive modes of transport. Also many environmental factors that have resulted from increased urbanisation can promote physical inactivity. (WHO, 2012c.)

For example, in the context of Finland, where this study was conducted, the changes in work and everyday life have had significant effects on physical activity and exercise habits. The physical activity of Finns has dropped drastically during the past 20 years (Juutinen-Finni, 2010; Koivumäki, 2003). Intentional exercise and sports began to become more common along with urbanisation and the shifts in time allocation patterns that took place in the 1960s. The field of exercise and sports became more versatile in the 1980s, and since the 1990s, commercialisation and the strengthened role of technology have been the two dominating trends in this area. As work as such has changed, more and more Finns work sedentary and even leisure time is dominated by sitting: one often spends time sitting in front of a television or a computer. Researchers have begun to talk about a sedentary lifestyle, which is associated with several severe health risks. It has also been suggested that the high levels of screen time can further promote the sedentary lifestyle, particularly among young people (Daley, 2009). The sedentary lifestyle has affected the physical fitness of Finns as well. In several extensive population studies, it has been found to decline considerably (Heiskanen et al., 2011; Santtila et al., 2006; Vaara et al., 2009).

Along with the sedentary lifestyle, intentional exercise and sports have become more common. Guidelines based on epidemiological studies have been suggested for the desired amount of exercise and sports, and the adherence of the Finnish population to these guidelines is being examined regularly. In terms of these guidelines, less than half of Finns take enough exercise for their health. If the physical activity of Finns remains at its present level and the decline of their physical fitness continues to follow its current trend, the physical fitness, particularly the aerobic fitness, of the Finnish population will decline drastically during the next 25 years (Heiskanen et al., 2011; Hirvensalo et al., 2011; Finnish Sports Federation, 2011). Therefore, it is of utmost importance to find new measures to motivate people to do more exercise and sports.

Prior research has revealed that the usage of sports and wellness technologies can promote the motivation towards exercise and sports (e.g., Ahtinen et al., 2008; Bravata et al., 2007). In the past years, these technologies have become an essential part of the everyday life of many people. A heart rate monitor is already a common training partner for many physically active people, and also the usage of other kinds of information and communication technology (ICT) based devices and services is becoming increasingly common. One example of these are *digital exercise games* or *exergames*, that require some sort of physical activity from the player in order to play the game. Prior research has demonstrated that exergames can promote the motivation towards physical activity and exercise (e.g., Bailey & McInnis, 2011; Berkovsky et al., 2010; Sallis, 2011), can have physiological benefits (e.g., Daley, 2009; Maddison et al., 2011), and can be utilised as a part of a more extensive aerobic exercise program (Siegel et al., 2009). Naturally, this depends on the type of the exergame and the physical exertion level at which the exergame is played. It has also been suggested that exergames are able to promote the motivation towards other forms of physical activity and, therefore, are also able to act as an incentive for an active lifestyle (Trout & Christie, 2007). Exergaming has also been suggested as a potential method for promoting the physical activity levels of those whose screen time is high (Daley, 2009). However, the research on exergames has, so far, been limited and the results mixed. Particularly the habits of playing these games and the reasons why they either are or are not played remain a relatively unexplored area. Therefore, there is a demand for more research on exergames, particularly on the habits of playing and reasons for playing and not playing them, as most of the prior research on exergames has concentrated on the physiological and motivational aspects of exergaming.

Concerning the gender differences in video game participation, relatively much prior research has been conducted, and men have often been found as more active players than females (e.g., Greenberg et al., 2010; Lucas, 2004; Ogletree & Drake, 2007). But this research has mostly concentrated on video games at a general level, and research in the context of exergames is lacking.

The purpose of this study is to address these shortcomings by examining the habits of playing and the reasons for not playing exergames, concentrating particularly on the gender differences between the male and female players and non-players. The explicit research questions that the study aims at answering can be formulated as follows: 1) what kinds of gender differences exist in the habits of playing exergames, and 2) what kinds of gender differences exist in the reasons for not playing exergames? The answers to these questions can be considered critical, among others, for the design and marketing of exergames. Of the different types of exergames, we concentrate on the games that are based on some sort of digital interface, be it a game console, a computer, or a mobile device, such as a mobile phone or a mobile music player. Because of the lack of prior research, the study is explorative in nature, meaning that habits of playing and the reasons for not playing exergames are examined at a descriptive level without utilising any prior theoretical framework. Methodologically, the study is based on analysing an online survey sample of 3,036 Finnish consumers through contingency tables, the Pearson's χ^2 tests of independence, and the Cramér's V coefficients.

The paper consists of six sections. After this introductory section, we discuss about the concept of exergames in Section 2. Sections 3 and 4 present the methodology and results of the study. The results are discussed in more detail in Section 5. Finally, Section 6 considers the limitations of the study and potential paths of future research.

2 Exergames

In the past years, different kinds of novel digital concepts that combine exercise and games have emerged. These have been called with different terms, such as exergames, exertainment, active-play video games, and active games (Lieberman et al., 2011). In the end, they all mean more or less the same thing: games that combine exercise and games by requiring some sort of physical activity from the player in order to play the game. Mueller et al. (2011, p. 2651) define exergames as “a digital game where the outcome of the game is predominantly determined by physical effort”. In this study, we adhere to this definition.

In general, three types of exergames can be identified. First, there are the screen-based games, which are typically played on a game console at home. These include the games for Nintendo Wii and Xbox Kinect as well as arcade games. Second, there are the mobile games, which utilise mobile phones, mobile music players, and other types of mobile devices as a platform for the games and typically aim at combining real and virtual world elements through augmented reality. Third, there are the light-sensor-based games, which utilise light-sensors in tracking the player and playing the games. (Lieberman et al., 2011.)

One of the main advantages of exergames is that they can promote the physical activity of the players without the players having a profound understanding on physical training (Bogost, 2005). Another advantage is that they can be used in many different settings, such as homes, fitness centres, senior centres, as well as medical and community settings. They can also be adapted to serve people of different ages and with different kinds of physical abilities and disabilities, cognitive capabilities, and rehabilitation needs. Respectively, they can be equipped with assessment and coaching features as well as with features for estimating the effects of playing on physical fitness through, for example, heart rate or energy expenditure measurements. (Lieberman et al., 2011.)

Prior research (e.g., Berkovsky et al., 2010) has suggested that exercise and games can be combined without adverse effects on the overall playing experience and enjoyment, demonstrating the potential of exergames to motivate people to do more exercise.

3 Methodology

To examine the habits playing and the reasons for not playing exergames, we conducted an online survey among Finnish consumers. The survey was created by using the LimeSurvey 1.91+ software, and before launching it online, we pre-tested it qualitatively with two postgraduate students and quantitatively with 56 undergraduate students. The survey was online for about one and a half months from 14 December 2011 to 31 January 2012. During this time, we actively promoted the survey link by posting it to several Finnish discussion forums focusing on a variety of topics as well as by sending several invitation e-mails through the internal communication channels of our university and an e-mail list provided by a Finnish company specialising in the testing of exercise devices. To raise the response rate, we also raffled 26 gift cards with a total worth of 750 € among the respondents.

The survey questionnaire consisted of several sections, and the total number of questionnaire items presented to each respondent varied from 46 to 130, depending on their responses. One of the sections was used to survey the respondents on their habits of playing and reasons for not playing exergames. The items in this section (translated from Finnish to English) are presented in Appendix. The section began by asking the respondents whether or not they played exergames. Those that stated to be playing, were classified as *players* and asked descriptive questions about their habits of playing, whereas those that stated not to be playing, were classified as *non-players* and asked about the reasons for this. Of course, a respondent also had an option to not answer this question at all, in which case no further questions were asked from him or her.

The descriptive questions about the habits of playing exergames that were included in this study were all closed-ended multiple choice questions and concerned the frequency of playing exergames on game consoles, computers, and mobile devices (at least weekly, at least monthly, less frequently than monthly, or has never played), the reason of playing (mainly for fun or mainly for exercise), the setting of playing (mainly in an individual setting or mainly in a group setting), the physical exertion level of playing (light, moderate, or vigorous), and the perceived effects of playing on physical fitness (negative, no effects, or positive). All the questions were optional, meaning that a respondent had the option to skip one or more of them. The reasons for not playing exergames were surveyed by using one open-ended question. Also this question was optional, so a respondent had the option to state one, multiple, or no reasons.

The collected data was analysed by using the IBM SPSS Statistics 19 software. The statistical significance and strength of the dependencies between the responses and gender were analysed through contingency tables, the Pearson's χ^2 tests of independence, and the Cramér's V coefficients. These enabled us to examine not only the linear but also the non-linear dependencies, which suited very well the explorative nature of the study.

The stated reasons for not playing exergames were analysed qualitatively by using inductive content analysis (Patton, 1990). First, all the reasons were read several times and preliminary categories were formed. Then, each reason was given a code that classified it under one of the categories. Similar reasons were classified under the same category. If a reason did not fit into any of the formed categories, a new category was formed. After all the reasons were classified, similar categories were combined into broader categories. The categories that consisted of only a few reasons were combined into a category called *other reasons*.

4 Results

In total, we received 3,036 valid responses to our survey. Of the 2,976 respondents who had stated whether or not they played exergames, 723 (24.3 %) were players and 2,253 (75.7 %) were non-players. Perhaps a bit surprisingly, the playing of exergames was slightly more common among women than among men. Of the 1,060 male respondents who had stated whether or not they played exergames, 236 (22.3 %) were players and 824 (77.7 %) were non-players. In contrast, of the 1,916 female respondents who had stated whether or not they played exergames, 487 (25.4 %) were players and 1,429 (74.6 %) were non-players. However, when tested with the Pearson's χ^2 test of independence, the dependency between gender and the playing of exergames was not quite statistically significant at the 0.05 level ($\chi^2(1) = 3.690$, $p = 0.055$).

	All (N = 3,036)		Players (N = 723)		Non-players (N = 2,253)	
	N	%	N	%	N	%
Gender						
Male	1,082	35.6	236	32.6	824	36.6
Female	1,954	64.4	487	67.4	1,429	63.4
Age						
–29 yrs.	1,204	39.7	384	53.1	785	34.8
30–39 yrs.	789	26.0	175	24.2	606	26.9
40–49 yrs.	593	19.5	127	17.6	457	20.3
50– yrs.	450	14.8	37	5.1	405	18.0
Yearly income						
–14,999 €	908	34.1	253	39.2	629	31.9
15,000–29,999 €	668	25.1	141	21.8	518	26.3
30,000–44,999 €	678	25.5	161	24.9	511	25.9
45,000– €	407	15.3	91	14.1	314	15.9
N/A	375	–	77	–	281	–
Socioeconomic group						
Student	768	25.3	228	31.5	520	23.1
Employed	1,797	59.2	410	56.7	1,367	60.7
Unemployed	210	6.9	46	6.4	156	6.9
Pensioner	121	4.0	9	1.2	107	4.7
Other	140	4.6	30	4.1	103	4.6

Table 1: Descriptive statistics of the entire sample and the two sub-samples

Descriptive statistics of the entire sample as well as the sub-samples of players and non-players are presented in Table 1. Overall, the gender, age, and income distributions of the entire sample correspondent very well the gender and age distributions of the Finnish Internet population as well as the income distribution of the Finnish income recipients in 2010 (Statistics Finland, 2012). Women and the youngest age group were slightly overrepresented, whereas men and the two oldest age groups were slightly underrepresented. However, there were no indications of severe non-response bias in terms of the three variables. The entire sample can also be characterised very heterogeneous in terms of the socioeconomic group of the respondents.

In the next two subsections, the habits of playing exergames among the players and the reasons for not playing exergames among the non-players are examined in more detail.

4.1 Habits of Playing Exergames

The responses to the seven descriptive questions about the habits of playing exergames are summarised in Table 2, first for all the players and then for the male and female players. Table 3 summarises the results of the Pearson's χ^2 tests of independence that were used to examine the statistical significance and strength of the dependencies between gender and the responses.

In terms of the devices of playing, the responses suggest that exergames are most frequently played on game consoles and relatively infrequently on computers and mobile devices. Of the players who responded these questions, 312 (43.2 %) stated that they were playing exergames on game consoles at least monthly, 49 (6.8 %) stated that they were playing them on computers at least monthly, and 23 (3.2 %) stated that they were playing them on mobile devices at least monthly. Gender was found to have no

	All players (N = 723)		Male players (N = 236)		Female players (N = 487)	
	N	%	N	%	N	%
Playing on game consoles						
At least weekly At	121	16.9	38	16.3	83	17.1
least monthly	191	26.6	77	33.0	114	23.6
Less than monthly	390	54.4	114	48.9	276	57.0
Has never played	15	2.1	4	1.7	11	2.3
N/A	6	–	3	–	3	–
Playing on computers						
At least weekly At	21	3.0	10	4.3	11	2.3
least monthly	28	4.0	17	7.4	11	2.3
Less than monthly	152	21.7	67	29.0	85	18.1
Has never played	500	71.3	137	59.3	363	77.2
N/A	22	–	5	–	17	–
Playing on mobile devices						
At least weekly At	11	1.6	7	3.0	4	0.9
least monthly	12	1.7	6	2.6	6	1.3
Less than monthly	83	11.9	46	19.9	37	7.9
Has never played	591	84.8	172	74.5	419	89.9
N/A	26	–	5	–	21	–
Reason of playing						
Fun	602	85.3	211	92.1	391	82.0
Exercise	104	14.7	18	7.9	86	18.0
N/A	17	–	7	–	10	–
Setting of playing						
Individual	157	22.1	47	20.2	110	23.1
Group	552	77.9	186	79.8	366	76.9
N/A	14	–	3	–	11	–
Exertion of playing						
Light	239	34.3	101	45.3	138	29.2
Moderate	425	61.1	115	51.6	310	65.5
Vigorous	32	4.6	7	3.1	25	5.3
N/A	27	–	13	–	14	–
Effects of playing						
Negative	4	0.6	4	1.8	0	0.0
No effects	529	81.5	187	85.0	342	79.7
Positive	116	17.9	29	13.2	87	20.3
N/A	74	–	16	–	58	–

Table 2: The habits of playing exergames among the players

	N	χ^2	df	p	V
Playing on game consoles	717	7.516	3	0.057	0.102
Playing on computers	701	27.306	3	**< 0.001**	**0.197**
Playing on mobile devices	697	29.100	3	**< 0.001**	**0.204**
Reason of playing	706	12.738	1	**< 0.001**	**0.134**
Setting of playing	709	0.783	1	0.376	0.033
Exertion of playing	696	17.825	2	**< 0.001**	**0.160**
Effects of playing	649	12.396	2	**0.002**	**0.138**

Table 3: Gender dependencies in the habits of playing exergames among the players

statistically significant dependency with the playing on game consoles ($\chi^2(3) = 7.516$, $p = 0.057$), but it was found to have a statistically significant dependency with the playing on both computers ($\chi^2(3) = 27.306$, $p < 0.001$, $V = 0.197$) and mobile devices ($\chi^2(3) = 29.100$, $p < 0.001$, $V = 0.204$). In the case of both computers and mobile devices, men were found to be more frequent players than women.

In terms of the reason of playing, the responses suggest that exergames are played mostly for fun. Of the 706 players who responded this question, 602 (85.3 %) stated that they were playing exergames mainly for fun related reasons and 104 (14.7 %) stated that they were playing exergames mainly for exercise related reasons. Gender was found to have a statistically significant dependency with the reason of playing ($\chi^2(1) = 12.738$, $p < 0.001$, $V = 0.134$), with men playing exergames more for fun and women more for exercise. Of the 229 male players who responded this question, 211 (92.1 %) stated to be playing mainly for fun and 18 (7.9 %) stated to be playing mainly for exercise. In contrast, of the 477 female players who responded this question, 391 (82.0 %) stated to be playing mainly for fun and 86 (18.0 %) stated to be playing mainly for exercise.

In terms of the setting of playing, the responses suggest that exergames are played mainly in a group setting. Of the 709 players who responded this question, 552 (77.9 %) stated that they were playing exergames mainly in a group setting and 157 (22.1 %) stated they were playing exergames mainly in an individual setting. Perhaps a bit surprisingly, gender was found to have no statistically significant dependency with the setting of playing ($\chi^2(1) = 0.783$, $p = 0.376$).

In terms of the physical exertion of playing, the responses suggest that exergames are played mainly at moderate or light exertion levels. Of the 696 players who responded this question, 425 (61.1 %) stated to be playing mainly at a moderate level, 239 (34.3 %) at a light level, and only 32 (4.4 %) at a vigorous level. Gender was found to have a statistically significant dependency with the physical exertion of playing ($\chi^2(2) = 17.825$, $p < 0.001$, $V = 0.160$), with women playing at more vigorous exertion levels. Of the 223 male players who responded this question, 115 (51.6 %) stated to be playing mainly at a moderate level, 101 (45.3 %) at a light level, and 7 (3.1 %) at a vigorous level. In contrast, of the 473 female players who responded this question, 310 (65.5 %) stated to be playing mainly at a moderate level, 138 (29.2 %) at a light level, and 25 (5.3 %) at a vigorous level.

In terms of the perceived effects of playing, the responses suggest that the playing of exergames is not perceived as having significant effects on physical fitness. Of the 649 players who responded this question, 529 (81.5 %) stated to have perceived no effects, 116 (17.9 %) stated to have perceived positive effects, and 4 (0.6 %) stated to have perceived negative effects. Gender was found to have a statistically significant dependency with the perceived effects of playing ($\chi^2(2) = 12.396$, $p = 0.002$, $V = 0.138$), with women perceiving more positive effects on their physical fitness. Of the 220 male players who responded this question, 187 (85.0 %) stated to have perceived no effects, 29 (13.2 %) stated to have perceived positive effects, and 4 (1.8 %) stated to have perceived negative effects. In contrast, of the 429 female players who responded this question, 342 (79.7 %) stated to have perceived no effects and 87 (20.3 %) stated to have perceived positive effects. None of the female players who responded this question stated to have perceived negative effects.

4.2 Reasons for not Playing Exergames

Of the 2,253 non-players, 1,855 (82.3 %) stated one or multiple reasons for not playing exergames. Most (73.0 %) stated just one reason, but some stated two (22.6 %), three (4.3 %), and four (0.1 %) reasons. The total number of stated reasons was 2,438. By classifying these into broader categories, we identified 11 main reasons for not playing exergames: *no interest*, *prefers other forms of exercise*, *ownership*, *no money*, *not useful enough*, *not a gamer*, *no time*, *not familiar*, *home restrictions*, *personal restrictions*, and *other reasons*. Examples of the stated reasons that were classified into each category, translated from Finnish to English, are presented in Table 4.

Reason for not playing	Examples of stated reasons
No interest	Not interested, does not motivate, do not like, do not care
Prefers other forms of exercise	Prefers exercising outside / in a group / other forms of exercise
Ownership	Does not own, has not bought
No money	The price, too expensive, can not afford
Not useful enough	Does not perceive useful, not demanding enough physically, no need
Not a gamer	Does not play any digital games, never played digital games
No time	Lack of time, not enough time, no free time for exergaming
Not familiar	Not familiar, has not even heard, unknown
Home restrictions	No space for exergaming / devices, neighbours
Personal restrictions	Age (too old), crippled, weight, physical / bodily restrictions
Other reasons	Too much screen time as it is, kids, other

Table 4: The reasons for not playing exergames and examples of the stated reasons

The number and the percentage of the non-players that stated the aforementioned 11 reasons as their reason for not playing exergames are presented in Table 5, first for all the non-players and then for the male and female non-players. Table 6 summarises the results of the Pearson's χ^2 tests of independence that were used to examine the statistical significance and strength of their dependencies between gender and the statement of the reasons.

	All non-players (N = 2,253)		Male non-players (N = 824)		Female non-players (N = 1,429)	
	N	%	N	%	N	%
No interest	533	23.7	229	27.8	304	21.3
Prefers other forms of exercise	490	21.7	157	19.1	333	23.3
Ownership	409	18.2	125	15.2	284	19.9
No money	279	12.4	47	5.7	232	16.2
Not useful enough	271	12.0	101	12.3	170	11.9
Not a gamer	163	7.2	51	6.2	112	7.8
No time	128	5.7	55	6.7	73	5.1
Not familiar	63	2.8	16	1.9	47	3.3
Home restrictions	50	2.2	15	1.8	35	2.4
Personal restrictions	26	1.2	12	1.5	14	1.0
Other reasons	26	1.2	5	0.6	21	1.5

Table 5: The reasons for not playing exergames among the non-players

	N	χ^2	df	p	V
No interest	2,253	21.293	1	**< 0.001**	**0.074**
Prefers other forms of exercise	2,253	5.546	1	**0.019**	**0.050**
Ownership	2,253	7.784	1	**0.005**	**0.059**
No money	2,253	53.423	1	**< 0.001**	**0.154**
Not useful enough	2,253	0.064	1	0.800	0.005
Not a gamer	2,253	2.116	1	0.146	0.031
No time	2,253	2.393	1	0.122	0.033
Not familiar	2,253	3.490	1	0.062	0.039
Home restrictions	2,253	0.953	1	0.329	0.021
Personal restrictions	2,253	1.041	1	0.308	0.021
Other reasons	2,253	3.410	1	0.065	0.039

Table 6: Gender dependencies in the reasons for not playing exergames among the non-players

As can be seen, the four most significant reasons for not playing exergames were the *no interest* (stated by 23.7 % of all the non-players), *prefers other forms of exercise* (21.7 %), *ownership* (18.2 %), and *no money* (12.4 %). These were also the only reasons in which there was a statistically significant dependency with gender. The strongest dependency (V = 0.154) was in the reason *no money*, which was stated by 16.2 % of the female non-players and 5.7 % of the male non-players. The second strongest dependency (V = 0.074) was in the reason *no interest*, which was stated by 27.8 % of the male non-players and 21.3 % of the female non-players. The third strongest dependency (V = 0.059) was in the reason *ownership*, which was stated by 15.2 % of the male non-players and 19.9 % of the female non-players. Finally, the fourth strongest dependency (V = 0.050) was in the reason *prefers other forms of exercise*, which was stated by 19.1 % of the male non-players and 23.3 % of the female non-players. In the case of the remaining seven reasons, *not useful enough* (stated by 12.0 % of all the non-players), *not a gamer* (7.2 %), *no time* (5.7 %), *not familiar* (2.8 %), *home restrictions* (2.2 %), *personal restrictions* (1.2 %), and *other reasons* (1.2 %), there was no statistically significant dependency with gender.

5 Discussion and Conclusions

In this study, we examined the habits of playing and the reasons for not playing exergames, concentrating particularly on the gender differences between the male and female players and non-players. In terms of the habits of playing exergames, our results suggest that by far the most popular platform for playing exergames are game consoles, and very few people play them with computers or mobile devices. This is not surprising when considering that a majority of exergames are released only for game consoles. However, at the same time, it also highlights the market potential of other platforms, particularly mobile devices, in which the penetration rates are still very low. The results also suggest that exergames are mainly played for fun and in a group setting. Therefore, when designing the games, it is important to make them as entertaining as possible and, if reasonable, to equip them with good multiplayer features.

In terms of the gender differences in the habits of playing exergames, our results suggest no difference in the popularity of playing exergames between men and women. However, there seems to be differences in the reasons of playing exergames between men and women. Although both men and women were found to play exergames mainly for the hedonic reason of having fun, the utilitarian exercise related reasons were more popular among women than among men. This is in line with the finding that women also played exergames at more vigorous exertion levels and perceived the effects of playing on their physical fitness more positively than men. Thus, if exergames are marketed more as a means for exercising than as a means of having fun, women can perhaps be considered more potential targets for these kinds of marketing messages.

In terms of the reasons of not playing exergames, our results suggest that the most significant reason for not playing exergames was the *lack of interest* towards them. The second most significant reason was that a person *prefers other forms of exercise* to exergames. The lack of *ownership* was the third most significant reason. Also some differences between men and women were found. Among men, the three most significant reasons for not playing were 1) *lack of interest*, 2) *prefers other forms of exercise*, and 3) *ownership*. Among women, the three most significant reasons for not playing were 1) *prefers other forms of exercise*, 2) *lack of interest,* and 3) *ownership*. In other words, the same reasons but in a different order. The reasons that were stated more frequently by women than by men were *prefers other forms of exercise, ownership*, and *no money*. The only reason that was stated more frequently by men than by women was *lack of interest*. The most significant difference between men and women was in the reason *no money*. As the income differences between men and women in Finland are relatively insignificant and the prices of exergames are relatively low, perhaps the main explanation for this finding is that women are less aware of the actual prices of exergames than men. However, this requires further research.

Based on these results, it seems that exergames still have a long way to go before they are perceived as interesting enough in terms of the gaming experience as well as useful enough in terms of their effects on physical fitness. Thus, it is critical that the game industry concentrates on addressing these issues in game design. One aspect that might aid in addressing both of these issues could be to design the games to be physically more demanding as this could result in them being perceived not only as more useful but also as more interesting. But, of course, the games should not be designed as physically too demanding as this could result in them not being perceived fun anymore. Overall, finding the equilibrium between the hedonic and utilitarian aspects of exergames seems to be the main challenge facing the game designers today and most probably also in the years to come.

6 Limitations and Future Research

In terms of the habits of playing exergames, the main limitations of this study relate to the operationalisation of some of the surveyed concepts, such as the reason, setting, exertion, and effects of playing, in a relatively simplistic manner, in which they were measured with only one question. This was due to the explorative nature of the study. However, future studies may benefit from more rigorous operationalisations in which the concepts are measured with multiple questions so that the reliability and validity of the measures can be evaluated. All the questions also concentrated on subjective rather than objective measures of the concepts (e.g., *perceived* exertion of playing and *perceived* effects of playing). In this study, we also did not examine the relationships between the concepts. In terms of the reasons for not playing, the main limitation of the study relates to the usage of an online survey to collect the data, which obviously prevented us from asking any follow-up questions related to the reasons and may have caused some of the respondents to state the reasons in a rather simplistic manner or even leave some of the reasons unstated. Thus, future studies may benefit from the usage of other methods, such as personal or group interviews, to collect the data. Many of the reasons were also very closely related to each other, perhaps even through causal relations (e.g., some people may not be interested in exergames *because* they do not perceive them as useful enough). However, these relationships between the reasons were not examined in this study.

Acknowledgements

The authors wish to acknowledge the Tourism and Leisure Services Programme of Tekes, the Finnish Funding Agency for Technology and Innovation, and the companies participating in the Sedospo project for their funding of this study.

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Appendix

The questionnaire that was used to the respondents on their habits of playing and reasons for not playing exergames (translated from Finnish to English) is presented below. Questions 2, 3, 4, 5, 6, and 7 were asked if the respondent answered *Yes* to question 1. Question 8 was asked if the respondent answered *No* to question 1. If the respondent answered *Don't know* to question 1, no additional questions were asked from him or her.

Digital exercise games

By digital exercise games we mean to digital games in which the playing is mainly done by moving your own body. These include both game console and computer games (e.g., Nintendo Wii Fit and Sports, EA Sports Active, Your Shape, Zumba Fitness, and Dance Dance Revolution) and mobile games that can be played with mobile devices like mobile phones (e.g., Bjong, FlagHunt, TrezrHunt, and Lappset Mobile Playground).

1. Do you play digital exercise games?

- Yes
- No
- Don't know

2. On average, how often do you play digital exercise games with the following devices?

	Daily	Weekly	Monthly	Less than monthly	Only tried once or twice	Never tried	Don't know
Game console	○	○	○	○	○	○	○
Computer	○	○	○	○	○	○	○
Mobile device	○	○	○	○	○	○	○
Other device	○	○	○	○	○	○	○

3. What digital exercise games do you play?

[*Open-ended question*]

4. Do you play digital exercise games mainly for fun or for exercise?

- ○ Mainly for fun
- ○ Mainly for exercise
- ○ Don't know

5. Do you play digital exercise games mainly alone or together with other people?

- ○ Mainly alone
- ○ Mainly together with other people physically in the same space
- ○ Mainly together with other people virtually over a network
- ○ Don't know

6. At what physical exertion level do you mainly play digital exercise games?

- ○ Light (no sweating or accelerated breathing)
- ○ Moderate (some sweating and accelerated breathing)
- ○ Vigorous (strong sweating and accelerated breathing)
- ○ Don't know

7. How do you perceive that the playing of digital exercise games has affected your physical fitness?

- ○ Significantly negatively
- ○ Somewhat negatively
- ○ No significant effect
- ○ Somewhat positively
- ○ Significantly positively
- ○ Don't know

8. Why do you not play digital exercise games or possibly own devices or games required to play them?

[*Open-ended question*]

VII

EXPLAINING THE USAGE INTENTIONS OF EXERCISE MONITORING DEVICES: THE USAGE OF HEART RATE MONITORS IN FINLAND

by

Markus Makkonen, Lauri Frank, Tuomas Kari & Panu Moilanen, 2012

Proceedings of the 18th Americas Conference on Information Systems (AMCIS 2012), Paper 13, 10 pages

Explaining the Usage Intentions of Exercise Monitoring Devices: The Usage of Heart Rate Monitors in Finland

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ABSTRACT

Today, more and more people are using different types of exercise monitoring devices to measure their physical exercise activities. However, the underlying reasons for using these devices remain vaguely understood. This study aims at addressing this shortcoming by first proposing a theoretical model for explaining the usage intentions of exercise monitoring devices and then empirically testing it in the case of one common type of these devices: heart rate monitors. The model is based on a synthesis of three distinct theoretical domains – the theory of planned behaviour, the innovation diffusion theory, and the typology of consumer value – and it is tested by analysing an online survey sample of 3,036 Finnish consumers, or more specifically a sub-sample of 1,250 Finnish heart rate monitor owners, through structural equation modelling. The results of the analysis are also used to draw implications for the design and marketing of heart rate monitors.

Keywords

Usage intentions, exercise monitoring devices, heart rate monitors, theory of planned behaviour, innovation diffusion theory, typology of consumer value, structural equation modelling, online survey.

INTRODUCTION

Today, more and more people are using different types of information and communication technology (ICT) based self-monitoring devices to measure various aspects of their lives (e.g., Li, 2011). One common type of these devices are exercise monitoring devices that people use to measure their physical exercise activities. For example, many of us carry a pedometer in our pocket to count our daily steps or wear a heart rate monitor around our chest and wrist when we go out jogging. However, although commonly used, there seems to be considerable differences in the reasons why people use these devices. For some, the reasons may be related to general physical health and well-being, whereas others may reach for some much more specific goals, such as improving their physical performance in a particular sport or shaping their physical appearance by losing weight or gaining muscles. Yet for others, the reasons may be related to the ability of the devices to make exercise more fun or to the social advantages resulting from just wearing them. For example, some people may wear a heart rate monitor around their wrist in order to give an active impression of themselves to other people. Or less egoistically, a caring parent may do the same in order to altruistically encourage his or her children to adopt an active lifestyle. These are just a few examples of the plethora of possible reasons.

So far, most prior studies on exercise monitoring devices have adhered to a rather device-centric perspective and examined topics like their measurement accuracy, reliability, and validity as well as their ability to promote physical activity (e.g., Eston, Rowlands, and Ingledew, 1998; Terbizan, Dolezal, and Albano, 2002; Crouter, Schneider, Karabulut, and Bassett, 2003; Schneider, Crouter, Lukajic, and Bassett, 2003; Crouter, Albright, and Bassett, 2004; Bravata, Smith-Spangler, Sundaram, Gienger, Lin, Lewis, Stave, Olkin, and Sirard, 2007; Nunan, Donovan, Jakovljevic, Hodges, Sandercock, and Brodie, 2009). In contrast, few prior studies have adhered to a more user-centric perspective and examined topics like the aforementioned reasons for using the devices. This can be seen as a significant shortcoming because an understanding of these reasons can be considered a critical prerequisite, among others, for the analytical promotion of their adoption and diffusion with appropriate design and marketing decisions. The present study aims at addressing this shortcoming by first proposing a theoretical model for explaining the usage intentions of exercise monitoring devices and then empirically testing it in the case of one common type of these devices: heart rate monitors. Methodologically, the testing is done by analysing an online survey sample of 3,036 Finnish consumers, or more specifically a sub-sample of 1,250 Finnish heart rate monitor owners, through structural equation modelling (SEM).

By *heart rate monitors* (HRMs), we refer to mobile devices that measure the heart rate of their users. A modern HRM typically consists of two wirelessly connected components: a measurement unit, which is usually attached around the chest, and a display and storage unit, which is usually attached around the wrist like a wristwatch. As suggested by their names, the measurement unit takes care of the actual heart rate measurement, whereas the display and storage unit displays the measurements to the users and stores them for subsequent use. In addition to a heart rate sensor, a modern HRM may also contain additional sensors that augment the heart rate data with, for example, stride and position data. In the recent years, the wristwatch-like display and storage units have also been increasingly replaced with mobile phones equipped with suitable HRM software. Together with the decreasing prices of the measurement units, this has rapidly promoted the prevalence and pervasiveness of HRMs in everyday life.

This paper consists of six sections. After this introductory section, we propose our theoretical model for explaining the usage intentions of exercise monitoring devices in Section 2. Sections 3 and 4 present the methodology and results of the study. The results are discussed in more detail in Section 5, which also uses them to draw implications for the design and marketing of HRMs. Finally, Section 6 considers the limitations of the study and potential paths of future research.

THEORETICAL MODEL

Our theoretical model for explaining the usage intentions of exercise monitoring devices is based on a synthesis of three distinct theoretical domains: the theory of planned behaviour (TPB) by Ajzen (1985, 1991), the innovation diffusion theory (IDT) by Rogers (2003), and the typology of consumer value (TCV) by Holbrook (1996, 1999). TPB, which is an extension of the theory of reasoned action (TRA) by Fishbein and Ajzen (1975, 1980) and one of the most commonly used theories for explaining human behaviour, was used as the backbone of the model. A schematic illustration of TPB is presented in Figure 1 (the dashed elements are omitted in this study). In accordance with TPB, we hypothesised that the usage intentions of exercise monitoring devices could be explained by three factors: the attitude towards their usage, the subjective norm towards their usage, and the perceived behavioural control over their usage. Here, *attitude* refers to an individual's positive or negative evaluations of performing a behaviour, whereas *subjective norm* refers to an individual's perception of social pressure to perform or not to perform it. *Perceived behavioural control*, in turn, refers to an individual's perception of capacity, autonomy, and self-efficacy to perform it. Each of these three factors was hypothesised to have a positive effect on the usage intentions, meaning that the more positive the attitude towards the usage and the stronger the subjective norm towards and the perceived behavioural control over it, the stronger the usage intentions should be.

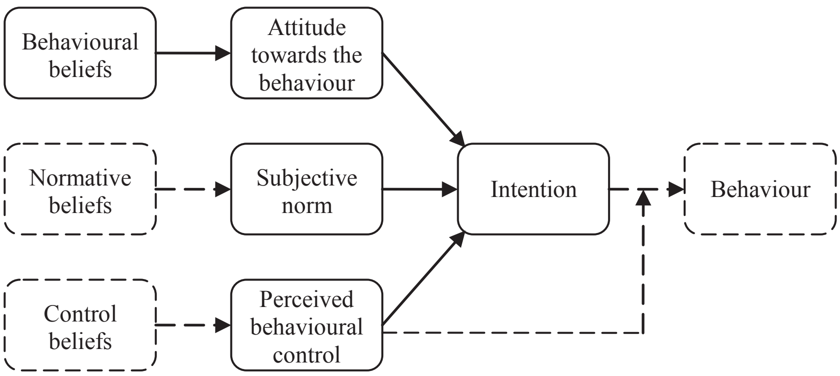

Figure 1. The theory of planned behaviour (Ajzen, 1985, 1991)

In addition to explaining the usage intentions of exercise monitoring devices with the three aforementioned factors, we also aimed at explaining the attitude towards their usage with behavioural beliefs on the outcomes of the usage. This, of course, could also have been done for subjective norm and perceived behavioural control with normative beliefs and control beliefs. However, in this study, we decided to concentrate only on attitude, which most prior studies have identified as the most important explanatory factor for intentions (Fishbein and Ajzen, 2010). In accordance with the decomposed theory of planned behaviour (DTPB) by Taylor and Todd (1995), we decomposed the behavioural beliefs into three distinct belief dimensions derived from IDT by Rogers (2003), which, in addition to perceived trialability and perceived observability, are hypothesised to be the most important explanatory factors for the rate of adoption of an innovation: perceived relative advantage, perceived complexity, and perceived compatibility. However, we differed from the original DTPB in three respects. First, we replaced the concept of *perceived complexity*, which in IDT is defined as the degree to which an innovation is perceived as relatively difficult to understand and use, with the contrary concept of *perceived ease of use* from the technology acceptance model (TAM) by Davis, Bagozzi, and Warshaw (1989), in which it is defined as the degree to which a person believes that using a particular system would be free from effort. To differentiate it from the concept of perceived behavioural control, we also defined it more specifically as the freedom from cognitive effort. In accordance with the original TAM, this concept was hypothesised to have a positive effect on attitude. Second, in addition to *perceived compatibility*, which in IDT is defined as the degree to which an innovation is perceived as consistent with the existing values, past experiences, and needs of potential adopters, we included in the model the concept of *perceived discomfort*, which we defined more specifically as the degree to which the usage of an innovation is perceived as causing physical discomfort, inconvenience, or distraction to its users. We consider this concept extremely important in the case of exercise monitoring devices as even a minor degree of perceived discomfort may have a major adverse effect on the overall exercise experience. Thus, contrary to the concept of perceived compatibility, this concept was hypothesised to have a negative effect on attitude.

Third, we replaced the concept of *perceived relative advantage*, which in IDT is defined as the degree to which an innovation is perceived as being better than the idea it supersedes, with the more comprehensive concept of *perceived value*, which more explicitly captures not only utilitarian but also hedonic and social perceptions of an innovation. More specifically, we included in the model four types of active value (efficiency, play, status, and ethics) that are defined in TCV by Holbrook (1996, 1999). In addition to these, TCV defines four types of reactive value (excellence, aesthetics, esteem, and spirituality). However, these were excluded from the model because we wanted to concentrate specifically on the value that derives from the active usage of the devices. A schematic illustration of TCV is presented in Figure 2 (the value dimensions and value types in parentheses are omitted in this study).

		Extrinsic	**Intrinsic**
Self-oriented	**Active**	Efficiency	Play
	(Reactive)	(Excellence)	(Aesthetics)
Other-oriented	**Active**	Status	Ethics
	(Reactive)	(Esteem)	(Spirituality)

Figure 2. The typology of consumer value (Holbrook, 1996, 1999)

In the context of exercise monitoring devices, we conceptualised the extrinsic and self-oriented *efficiency value* as the value deriving from the perceived ability of the devices to support the achievement of different types of utilitarian exercise goals more efficiently. We identified three types of these goals: physical health and well-being goals (e.g., maintaining one's physical health and well-being), physical performance goals (e.g., improving one's physical endurance, strength, speed, or agility), and physical appearance goals (e.g., losing weight, gaining muscles, or toning one's body). These were all included in the model as individual concepts, each of which was hypothesised to have a positive effect on attitude. The goals were derived from the revised motivation for physical activity measure (MPAM-R) scale by Ryan, Frederick, Lepes, Rubio, and Sheldon (1997), which defines five motivational dimensions for physical activity: fitness and health, competence and challenge, appearance, social, and enjoyment. The first three dimensions correspond to the aforementioned health and well-being, performance, and appearance goals. The fourth dimension, social, can also be considered a utilitarian goal, but it was excluded from the model because few exercise monitoring devices have an ability to strongly support its achievement. In contrast, the fifth dimension, enjoyment, is a hedonic goal, and, therefore, it associates better with the intrinsic and self-oriented *play value*, which we conceptualised as the value deriving from the perceived ability of the devices to support the achievement of different types of hedonic exercise goals (e.g., making exercise more fun, enjoyable, or pleasurable). This concept (included in the model as "enjoyment perceptions" in accordance with MPAM-R) was also hypothesised to have a positive effect on attitude. The extrinsic and other-oriented *status value* was conceptualised as the value deriving from the perceived ability of the devices to the give a more positive impression of their users to others. In this context, we defined this more specifically as giving others a more active impression of oneself. Finally, the intrinsic and other-oriented *ethics value* was conceptualised as the value deriving from the perceived ability of the devices to do something for the sake of others. In this context, we defined this more specifically as motivating or inspiring others to exercise in order for them to adopt an active lifestyle. Both status and ethics perceptions were hypothesised to have a positive effect on attitude. The final form of the theoretical model is illustrated in Figure 3.

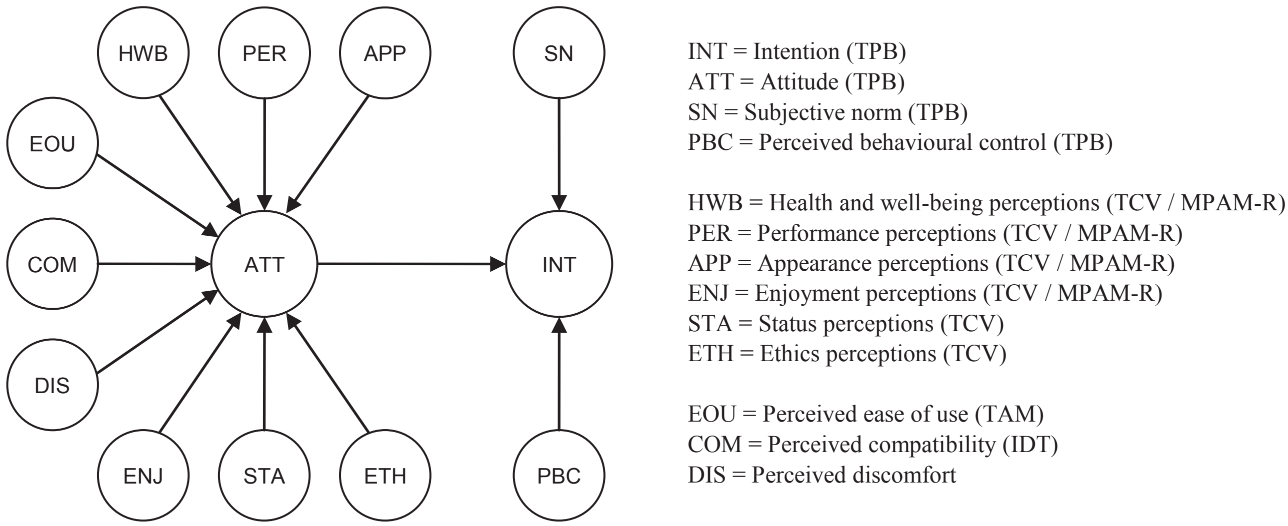

Figure 3. The model for explaining the usage intentions of exercise monitoring devices

METHODOLOGY

To test the theoretical model, we conducted an online survey among Finnish consumers. The survey was created by using the LimeSurvey 1.91+ software, and before launching it online, we pre-tested it qualitatively with two postgraduate students and quantitatively with 56 undergraduate students. The survey was online for about one and a half months from 14 December, 2011 to 31 January, 2012. During this time, we actively promoted the survey link by posting it to several Finnish discussion forums focusing on a variety of topics as well as by sending several invitation e-mails through the internal communication channels of our university and an e-mail list provided by a Finnish company specialising in the testing of exercise devices. To raise the response rate, we also raffled 26 gift cards with a total worth of 750 € among the respondents.

The survey questionnaire consisted of several sections, one of which was used to collect the data for testing the theoretical model. The other sections concentrated, among others, on the exercise habits of the respondents and their usage of three different types of exercise monitoring devices: pedometers, route trackers, and HRMs. Some of the sections and the items in them were conditional. For example, the data for testing the theoretical model was collected only from the respondents who owned a pedometer, a route tracker, or an HRM. This was to ensure that they all had an approximately equal chance to use the devices and at least a little experience with them. If a respondent owned multiple devices, he or she was first asked to select his or her most commonly used device and was then surveyed only on it. This was to avoid respondent fatigue, which was a potential problem as the number of items presented to each respondent varied from 46 to 130.

Each of the 13 constructs in the theoretical model was operationalised to be measured by three reflective indicators. The wordings of these 39 indicators, translated from Finnish to English, are presented in Appendix A. The operationalisations of the intention, attitude, subjective norm, and perceived behavioural control constructs followed the guidelines given by Fishbein and Ajzen (2010) as well as the examples by Taylor and Todd (1995). The intention, subjective norm, and perceived behavioural control constructs were each measured by using a seven-point Likert scale. As suggested by Fishbein and Ajzen (2010), the normative indicators were designed to capture both the descriptive (SN1 and SN2) and the injunctive (SN3 and SN2) aspects of normative evaluations, whereas the control indicators were designed to capture both the capacity (PBC1 and PBC2) and the autonomy (PBC3 and PBC2) aspects of control evaluations. The time horizon of the intention indicators was set to six months to cover both winter and summer sports. The attitude construct was measured by using a seven-point semantic differential scale. As suggested by Fishbein and Ajzen (2010), its indicators were designed to capture both the experiential (ATT2) and the instrumental (ATT3) aspects of attitudinal evaluations as well as overall attitude (ATT1).

The nine behavioural belief constructs were also measured by using a seven-point Likert scale. The operationalisations of the health and well-being, performance, appearance, and enjoyment perceptions constructs were based on the MPAM-R scale by Ryan et al. (1997). The operationalisation of the status perceptions construct was based on the study by Sweeny and Soutar (2001). The operationalisations of the perceived ease of use and compatibility constructs were based on the studies by Davis (1989) as well as Karahanna, Agarwal, and Angst (2006), and they concentrated specifically on cognitive ease of use and on compatibility with existing habits. For the operationalisations of the perceived discomfort and ethics perceptions constructs, no suitable examples were found in prior studies.

The analysis of the collected data was done by using the IBM SPSS Statistics 19 and the Mplus 6 software. SPSS was mainly used for data preparation and preliminary analysis, whereas Mplus was used for the actual SEM analysis.

RESULTS

In total, we received 3,036 valid responses to our online survey. Of the respondents, 1,256 owned only an HRM or owned multiple devices and selected the HRM as their most commonly used exercise monitoring device. After excluding six responses with missing values in all the indicator variables, this resulted in a sub-sample of 1,250 responses to be used for testing the theoretical model. The average response time for the entire survey among the respondents was about 20 minutes.

Descriptive statistics of the entire sample and the HRM sub-sample are presented in Table 1. Overall, the gender, age, and income distributions of the entire sample corresponded very well with the gender and age distributions of the Finnish Internet population as well as the income distribution of the Finnish income recipients in 2010 (Statistics Finland, 2012). Women and the youngest age group were slightly overrepresented, whereas men and the two oldest age groups were slightly underrepresented. However, there were no indications of severe non-response bias in terms of these three variables. The gender, age, and income distributions of the HRM sub-sample were very similar to those of the entire sample. Both the entire sample and the HRM sub-sample could also be characterised as very heterogeneous in terms of the socioeconomic group of the respondents and the percentage of the respondents who actively did or did not do some sport.

	Entire sample (N = 3,036)		**HRM sub-sample (N = 1,250)**	
	N	**%**	**N**	**%**
Gender				
Male	1,082	35.6	448	35.8
Female	1,954	64.4	802	64.2
Age				
–29 yrs.	1,204	39.7	473	37.8
30–39 yrs.	789	26.0	348	27.8
40–49 yrs.	593	19.5	268	21.4
50– yrs.	450	14.8	161	12.9
Yearly income				
–14,999 €	908	34.1	314	27.1
15,000–29,999 €	668	25.1	297	25.6
30,000–44,999 €	678	25.5	321	27.7
45,000– €	407	15.3	228	19.7
N/A	375	–	90	–
Socioeconomic group				
Student	768	25.3	285	22.8
Employed	1,797	59.2	830	66.4
Unemployed	210	6.9	57	4.6
Pensioner	121	4.0	34	2.7
Other	140	4.6	44	3.5
Actively does some sport				
Yes	2,150	74.7	1,079	89.6
No	728	25.3	125	10.4
N/A	158	–	46	–

Table 1. Descriptive statistics of the entire sample and the HRM sub-sample

Estimation Results

The model estimation was done by using the robust maximum likelihood (MLR) estimator, and the estimation results are presented on the left side of Figure 4. As can be seen, the model performed very well in explaining the usage intentions of and the attitudes towards using HRMs. Five out of the nine behavioural belief factors had a statistically significant effect on attitudes, and together they explained 53.6 % of the variance in them. As hypothesised, health and well-being perceptions, enjoyment perceptions, and perceived compatibility each had a positive effect, whereas perceived discomfort had a negative effect on attitudes. Contrary to our hypothesis, appearance perceptions were found to have a negative, although weak, effect on attitudes. Attitudes, in turn, together with subjective norm and perceived behavioural control, had a statistically significant and positive effect on usage intentions, and together they explained 61.0 % of the variance in them.

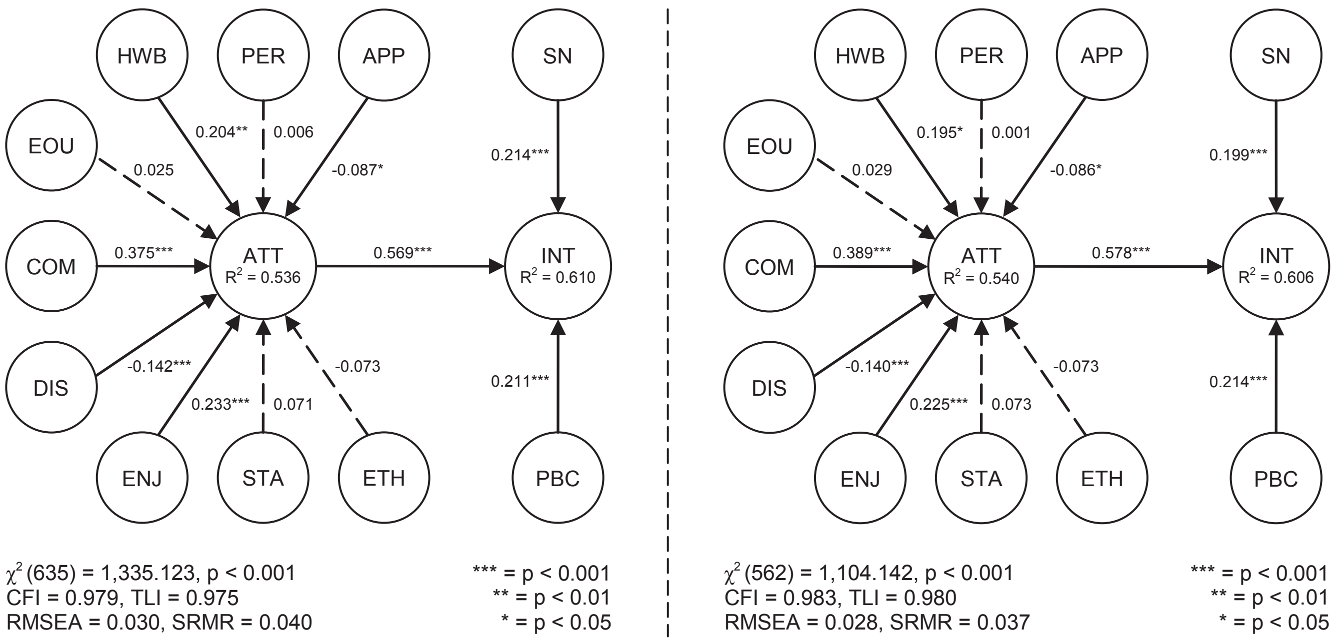

Figure 4. Estimation results before (left) and after (right) eliminating the indicators SN1 and COM3

In the next three sub-sections, the goodness of fit, reliability, and validity of the estimated model are evaluated on model, construct, and indicator levels.

Model Goodness of Fit

Model goodness of fit was evaluated by using the χ^2 test of model fit and four fit indices: the comparative fit index (CFI), the Tucker-Lewis index (TLI), the root mean square error of approximation (RMSEA), and the standardised root mean square residual (SRMR). Their values are presented in Figure 4. The χ^2 test rejected the null hypothesis of the model fitting the data. However, instead of actual misfit, this may have been due to the tendency of the χ^2 test to underestimate the fit in the case of large samples and complex models (Bentler and Bonett, 1980). In contrast, the values of the four fit indices clearly met the commonly accepted cut-off criteria for a satisfactory fit (CFI $\geq$ 0.95, TLI $\geq$ 0.95, RMSEA $\leq$ 0.06, and SRMR $\leq$ 0.08 – Hu and Bentler, 1999). Thus, overall, the estimated model can be seen as exhibiting a satisfactory fit with the data.

Construct Reliabilities and Validities

Construct reliabilities were evaluated by using composite reliabilities (CR – Fornell and Larcker, 1981). It is commonly expected that the CR of each construct should be greater than or equal to 0.7 in order for it to exhibit satisfactory reliability (Nunnally and Bernstein, 1994). The CR of each construct is listed in the first column of Table 2. As can be seen, all the constructs met this criterion.

Construct validities were evaluated by concentrating on the convergent and discriminant validity of the constructs. These were evaluated by using the two criteria proposed by Fornell and Larcker (1981). They both are based on the average variance extracted (AVE) of a construct, which refers to the average proportion of variance that a construct explains in its indicators. In order to exhibit satisfactory convergent validity, the first criterion requires that each construct should have an AVE greater than or equal to 0.5, meaning that, on average, each construct should explain at least half of the variance in its indicators. The AVE of each construct is listed in the second column of Table 2. As can be seen, all the constructs met this criterion. In order to exhibit satisfactory discriminant validity, the second criterion requires that each construct should have a square root of AVE greater than or equal to its absolute correlation with the other constructs, meaning that, on average, each construct should share at least an equal proportion of variance with its indicators than it shares with the other constructs. The square root of AVE of each construct (on-diagonal cells) and the correlations between the constructs (off-diagonal cells) are listed in the remaining columns of Table 2. As can be seen, all the constructs met also this criterion, although the self-oriented health and well-being, performance, appearance, and enjoyment perceptions constructs correlated strongly, as did the other-oriented status and ethics perceptions constructs. To ensure that these strong correlations would not cause problems due to multicollinearity, we also estimated the variance inflation factors (VIFs) of the constructs by using Mplus and SPSS. The only constructs that were found to have high VIFs were health and well-being perceptions (11.908) and performance perceptions (8.128), suggesting that it might be reasonable to unify these two constructs into one construct or to model them as first-order constructs of a second-order construct. However, as their VIFs were not exceedingly high and both the constructs had met the aforementioned criterion related to discriminant validity, we decided not to do this in this study.

Construct	CR	AVE	INT	ATT	SN	PBC	HWB	PER	APP	ENJ	STA	ETH	EOU	COM	DIS
INT	0.981	0.944	**0.972**												
ATT	0.888	0.725	0.702	**0.851**											
SN	0.762	0.524	0.533	0.379	**0.724**										
PBC	0.880	0.712	0.455	0.244	0.491	**0.844**									
HWB	0.944	0.850	0.452	0.570	0.388	0.209	**0.922**								
PER	0.947	0.857	0.449	0.545	0.422	0.227	0.900	**0.926**							
APP	0.935	0.826	0.305	0.379	0.306	0.113	0.736	0.680	**0.909**						
ENJ	0.956	0.879	0.471	0.600	0.414	0.195	0.816	0.745	0.675	**0.938**					
STA	0.951	0.866	0.191	0.228	0.239	0.045	0.426	0.363	0.574	0.454	**0.931**				
ETH	0.961	0.893	0.217	0.264	0.284	0.027	0.516	0.446	0.576	0.543	0.848	**0.945**			
EOU	0.895	0.741	0.398	0.429	0.370	0.353	0.373	0.404	0.237	0.318	0.117	0.142	**0.861**		
COM	0.812	0.595	0.538	0.651	0.467	0.321	0.530	0.545	0.346	0.553	0.197	0.229	0.607	**0.771**	
DIS	0.941	0.841	-0.353	-0.407	-0.333	-0.237	-0.244	-0.239	-0.142	-0.332	0.016	-0.022	-0.331	-0.381	**0.917**

Table 2. CRs, AVEs, square roots of AVEs (on-diagonal cells), and correlations (off-diagonal cells) of the constructs

Indicator Reliabilities and Validities

Indicator reliabilities and validities were evaluated by using the standardised loadings and residuals of the indicators, which are listed in Appendix B. In a typical case where each indicator loads on only one construct, it is commonly expected that the standardised loading (λ) of each indicator should be statistically significant and greater than or equal to 0.707 (Fornell and Larcker, 1981). This is equal to the standardised residual ($1 - \lambda^2$) of each indicator being less than or equal to 0.5, meaning that at least half of the variance in each indicator is explained by the construct on which it loads. As can be seen, the only indicators that did not meet this criterion were SN1 and COM3. Thus, after assessing that there would be no adverse effects on the content validity of the subjective norm and perceived compatibility constructs, we decided to eliminate them and to re-estimate the model. The re-estimation results are presented on the right side of Figure 4. As can be seen, the regression estimates remained essentially unchanged, but there was a slight improvement in the model goodness of fit.

DISCUSSION AND CONCLUSIONS

In this study, we first proposed a theoretical model for explaining the usage intentions of exercise monitoring devices and then empirically tested it in the case of Finnish HRM owners. Overall, the model was found to perform very well as it was able to explain more than 60 % of the variance in the usage intentions of HRMs and more than 50 % of the variance in the attitudes towards using HRMs. After eliminating two problematic indicators, the model was also found to exhibit satisfactory goodness of fit, validity, and reliability when evaluated on model, construct, and indicator levels.

This model can be considered the main theoretical contribution of the study as it not only promotes our theoretical understanding of the reasons behind the usage of exercise monitoring devices but also synthesises three distinct theoretical domains for explaining human behaviour – TPB, IDT, and TCV – into a new unified model, thus narrowing the theoretical gap between them. Although a similar synthesis has previously been performed between TPB and IDT (e.g., Taylor and Todd, 1995), we are not aware of it having been performed between TPB and TCV or all three of the theories.

The main practical contribution of the study are the estimation results of the model in the case of Finnish HRM owners, which can be used to draw some interesting implications for the design and marketing of HRMs. First, at least in Finland, it seems that the attitudes towards using HRMs are driven equally by the utilitarian perceptions on their ability to support the achievement of different types of health and well-being goals as well as the hedonic perceptions on their ability to make exercise more fun. Therefore, it is also important that both these aspects are given equal attention in the design and marketing of HRMs. In design, this could mean, for example, the development of HRM software that includes both utilitarian features like "virtual trainers", which instruct the users in their training, and hedonic features like exercise games or "exergames", which turn the training into more play than work. Respectively, in marketing, this could mean, for example, the launch of advertisement campaigns in which these utilitarian and hedonic features are communicated to the potential users of HRMs in an equal manner, without emphasising one aspect over the other.

Second, also perceived compatibility and discomfort were found to be significant drivers of the attitudes towards using HRMs, with perceived compatibility having a positive effect and perceived discomfort having a negative effect on them. Therefore, it is important that also these aspects are given adequate attention the design of HRMs through design decisions that increase the perceived compatibility and decrease the perceived discomfort of the devices among their target users. This, of course, first requires a thorough understanding of who actually are the target users and what are their exercising habits. If there are significant differences in these exercising habits, it may also require significant differentiation of the devices in both hardware and software respects, for example different devices for different sports. Here, of course, one has to consider whether this kind of differentiation is commercially sensible. In addition, as also perceived behavioural control was found to have a positive effect on the usage intentions of HRMs, the design decisions should also be such that they promote the perceptions of capacity, autonomy, and self-efficacy among the target users. In this, also perceived ease of use is likely to indirectly play an important part, although it was not found to have a direct effect on the attitudes towards using HRMs.

Third, social perceptions were found to have relatively insignificant effects on the usage of HRMs. For example, neither status nor ethics perceptions were found to have an effect on the attitudes towards their usage. In contrast, subjective norm was found to have a positive effect on their usage intentions, which would seem to emphasise the potential of different types of word-of-mouth based techniques in the marketing of HRMs. Fourth, surprisingly, appearance perceptions were found to have a negative, although weak, effect on the attitudes towards using HRMs, meaning that it could even be harmful to highlight the ability of HRMs to support the achievement of different types of appearance goals in their marketing. The explanations for this finding require a more thorough examination in future research. One explanation, of course, might be that many of the respondents in the survey sample were already quite pleased with their present appearance, which might have caused them to react negatively towards using HRMs if they associated this strongly with altering it.

LIMITATIONS AND FUTURE RESEARCH

The main limitation of this study is the fact that we empirically tested the proposed theoretical model for explaining the usage intentions of exercise monitoring devices only in the case of Finland and HRMs. Therefore, future research should aim at replicating this study in other countries and in the case of other types of exercise monitoring devices. This is actually already work in progress as the same online survey that was used to collect the data for this study was also used to collect similar data on pedometers and route trackers. However, the analysis of this data was omitted from this study due to space restrictions.

In this study, we also concentrated only on examining the regression relationships between the constructs and not, for example, the construct scores and means, which could have been used to examine the absolute and relative strengths of the constructs. Of the regression relationships, we also examined only the indirect effects of behavioural beliefs on usage intentions through attitudes and not the potential direct effects, which have been hypothesised to exist in models like TAM. Both these limitations remain to be addressed in future research. In addition, it would be interesting to extend the theoretical model to cover not only the usage intentions but also the actual usage of exercise monitoring devices.

ACKNOWLEDGMENTS

The authors wish to acknowledge the Tourism and Leisure Services Programme of Tekes, the Finnish Funding Agency for Technology and Innovation, and the companies participating in the Sedospo project for their funding of this study.

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APPENDIX A: INDICATORS

INT1 I intend to use an HRM to monitor my exercise activities in the next six months.
INT2 I plan to use an HRM to monitor my exercise activities in the next six months.
INT3 I am likely to use an HRM to monitor my exercise activities in the next six months.
ATT1 I think that the idea of me using an HRM to monitor my exercise activities in the next six months is bad … good.
ATT2 I think that the idea of me using an HRM to monitor my exercise activities in the next six months is unpleasant … pleasant.
ATT3 I think that the idea of me using an HRM to monitor my exercise activities in the next six months is useless … useful.
SN1 Many people who are important to me use an HRM to monitor their exercise activities.
SN2 Many people who are important to me think that it is a good idea to use an HRM to monitor one's exercise activities.
SN3 Many people who are important to me think that it is a good idea for me to use an HRM to monitor my exercise activities in the next six months.
PBC1 If I wanted to, I would be able to use an HRM to monitor my exercise activities in the next six months.
PBC2 If I wanted to, it would be possible for me to use an HRM to monitor my exercise activities in the next six months.
PBC3 It is up to me whether or not I use an HRM to monitor my exercise activities in the next six months.

I believe that by using an HRM to monitor my exercise activities in the next six months I can or could…

HWB1 …better maintain my physical health.
HWB2 …better maintain my physical ability to function.
HWB3 …better maintain my physical well-being.
PER1 …more efficiently improve my physical capacity.
PER2 …more efficiently improve my physical performances.
PER3 …more efficiently improve my physical capabilities (e.g., endurance, strength, speed, or agility).
APP1 …more efficiently improve my physical appearance.
APP2 …more efficiently shape my body.
APP3 …more efficiently lose weight, gain muscles, or tone my body.
ENJ1 …make my exercise more fun.
ENJ2 …make my exercise more enjoyable.
ENJ3 …make my exercise more pleasant.
STA1 …be perceived as a more active person by other people.
STA2 …give a more active impression of myself to other people.
STA3 …create a more active image for myself.
ETH1 …better motivate also other people to exercise.
ETH2 …better inspire also other people to exercise.
ETH3 …better encourage also other people to exercise.

I believe that using an HRM to monitor my exercise activities in the next six months…

EOU1 …would be clear and comprehensible to me.
EOU2 …would be easy for me to understand.
EOU3 …would be easy for me to learn.
COM1 …would be compatible with my current exercise habits.
COM2 …would not run counter to my current exercise habits.
COM3 …would not require changes in my current exercise habits.
DIS1 …would physically disturb me.
DIS2 …would feel to me physically uncomfortable.
DIS3 …would feel to me physically inconvenient.

APPENDIX B: INDICATOR LOADINGS AND RESIDUALS

Indicator	Loading	Residual
INT1	0.980***	0.040***
INT2	0.956***	0.085***
INT3	0.978***	0.043***
ATT1	0.877***	0.230***
ATT2	0.827***	0.316***
ATT3	0.849***	0.279***
SN1	0.534***	0.715***
SN2	0.781***	0.391***
SN3	0.823***	0.322***
PBC1	0.909***	0.174***
PBC2	0.894***	0.200***
PBC3	0.715***	0.489***

Indicator	Loading	Residual
HWB1	0.917***	0.159***
HWB2	0.915***	0.163***
HWB3	0.934***	0.128***
PER1	0.940***	0.116***
PER2	0.921***	0.151***
PER3	0.916***	0.161***
APP1	0.913***	0.167***
APP2	0.926***	0.142***
APP3	0.888***	0.212***

Indicator	Loading	Residual
ENJ1	0.947***	0.103***
ENJ2	0.917***	0.159***
ENJ3	0.949***	0.100***
STA1	0.936***	0.124***
STA2	0.941***	0.115***
STA3	0.915***	0.162***
ETH1	0.941***	0.114***
ETH2	0.954***	0.089***
ETH3	0.939***	0.119***

Indicator	Loading	Residual
EOU1	0.879***	0.227***
EOU2	0.878***	0.229***
EOU3	0.823***	0.322***
COM1	0.888***	0.212***
COM2	0.786***	0.382***
COM3	0.615***	0.621***
DIS1	0.899***	0.192***
DIS2	0.926***	0.142***
DIS3	0.925***	0.143***

*** = $p < 0.001$, ** = $p < 0.01$, * = $p < 0.05$