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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.

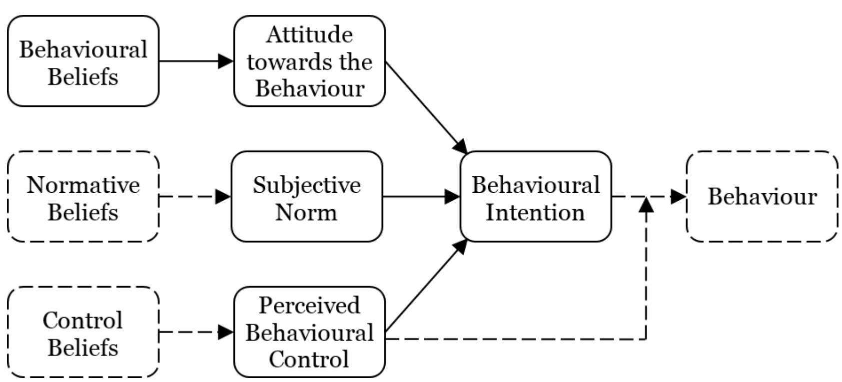

Figure 1. The theory of planned behavior (Ajzen, 1985, 1991)

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.

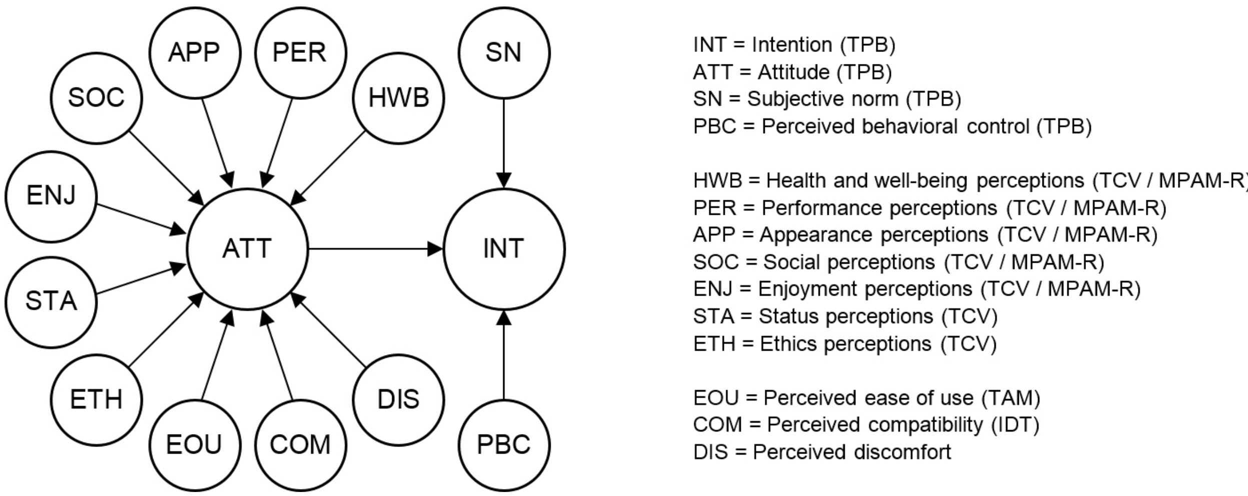

Figure 3. The theoretical model for explaining the usage intentions of exergames

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.

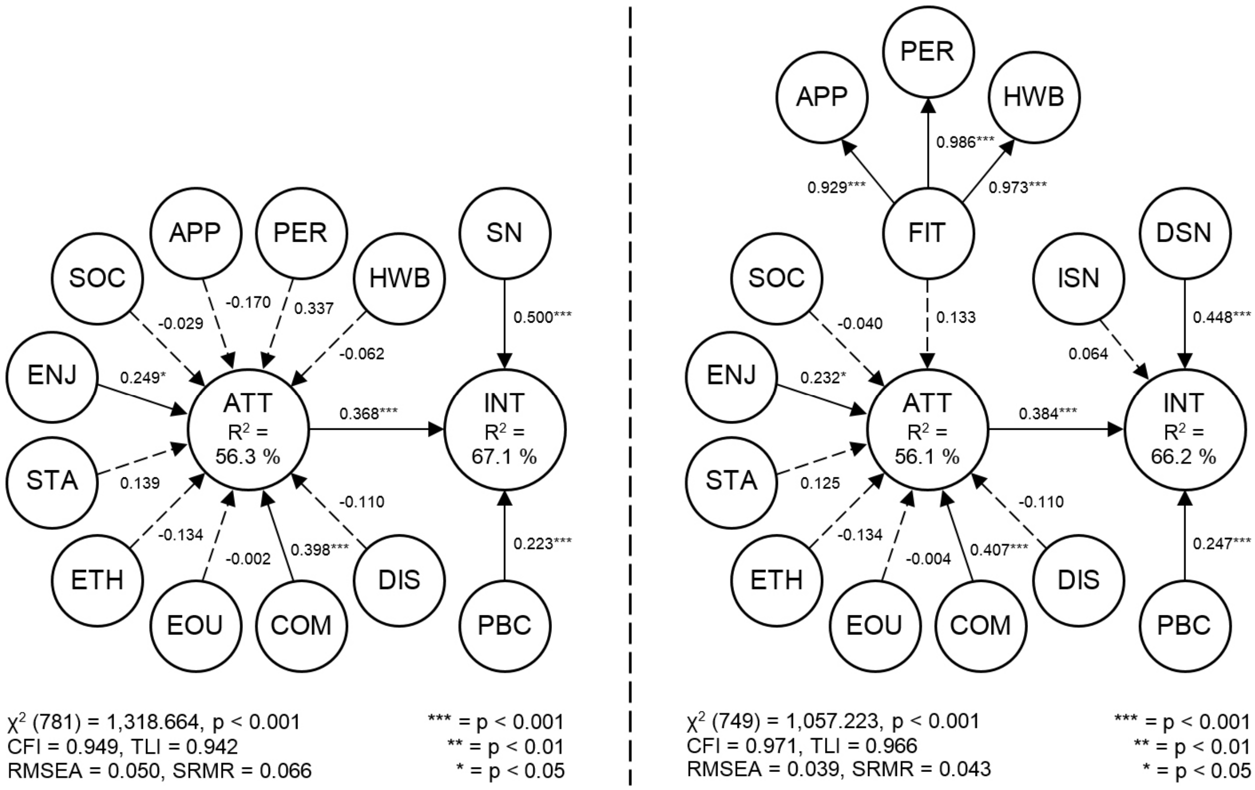

Figure 4. Estimation results before (left) and after (right) the model modifications

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^{**}