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 ($\chi 2$ (2) = 0.390, p = 0.823). However, there was a statistically significant difference ($\chi 2$ (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	$p_{(Monte\ Carlo)}$	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	$p_{(Monte\ Carlo)}$	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?

- o Yes
- o No
- o 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?

- o Mainly for fun
- o Mainly for exercise
- o 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?

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

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

- o Light (no sweating or accelerated breathing)
- o Moderate (some sweating and accelerated breathing)
- o Vigorous (strong sweating and accelerated breathing)
- o 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)