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Virtual Reality Arcades: A Study on Usage Habits with Emphasis on Digital Gaming

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Abstract. Virtual reality (VR) and VR gaming have seen substantial advancement during the recent years both in terms of technological development and the number of users. A notable rise has also occurred in the number of VR arcades. Despite the growing academic interest towards VR and VR gaming, there is still a dearth of understanding on the usage aspects of VR gaming and VR arcades. To address this gap, this study explored the habits of using VR arcades with emphasis on digital gaming. Specific focus was set on investigating differences between gender, age, and physical activity background. The study was exploratory in nature and based on a quantitative analysis of data collected from 126 respondents in Finland. The findings of this study bring new knowledge to this emerging subject, and thus, extend our understanding on the habits of using VR arcades and VR games. The study shows that digital gaming is clearly the most popular form of entertainment in VR arcades. Also, for the vast majority, the main purpose to visit VR arcades is gaming for fun, and it is more popular to visit VR arcades together with others than alone. The findings also demonstrate how VR gaming can be a new frontier for exergaming. Gender, age, and physical activity background differences are discussed. As a practical contribution, the findings are used to present implications for VR gaming and VR arcade stakeholders.

Keywords: Virtual Reality, VR, VR arcade, Digital Gaming, Exergaming, Entertainment, Usage Habits.

1 Introduction

During the recent decades, advancement in information technology has had a substantial impact on a number of fields, and digital gaming and entertainment are no exceptions. The emergence of novel sensors and other technological solutions has facilitated the design and development of digital games and other entertainment concepts. Such concepts have become increasingly multifaceted, not only from a technical perspective but also in respect to the wide variety of interaction possibilities available to the users.

A type of digital gaming and entertainment medium that has particularly benefited from the recent technological development is virtual reality (VR). VR can be defined in different ways and depending on the definition, include different kinds of solutions

[1]. These VR solutions are generally designed in order to produce realistic virtual environments and to immerse the user by utilizing image, sound, haptic, and other sensations. The common goal is to simulate the user's physical presence in a virtual environment. Contemporary VR solutions most commonly use VR headsets that are equipped with different features and connected to different technologies. For a well-covering overview of VR history, definitions, and technologies, see [1]. In this study, the focus regarding VR is in such VR technologies that include a VR headset, but as pointed out by [1], a headset is not the only way to carry out a VR experience. However, such focus is most suitable for the purpose of this study as the emphasis is on digital gaming in VR arcades, where such technologies are the ones most commonly used.

Different types of VR arcades have been emerging around the globe during the past years and their popularity seems to be on a constant rise [2,3]. In Finland, where this study was conducted, the number of VR arcades has been on a constant rise during the past few years. The types of VR experiences that different VR arcades provide vary a lot. Some are more focused on gaming whereas some are more focused on providing other forms of entertainment, such as audiovisual stories through VR or VR walks in the nature without any particular (game) goals. Most VR arcades seem to offer a variety of both games and other forms of entertainment, although the proportion of these varies between different VR arcades.

Academic interest towards investigating VR and VR gaming has increased steadily over the years, as the technology has become more accessible to different user groups. However, what has so far been quite limitedly studied is VR gaming – especially in the context of VR arcades. As the VR technology evolves, it affords new kinds of experiences and new ways of playing. Thus, there is a prevalent need to study the usage aspects of such VR solutions, for example, regarding the users, user behaviors, and issues such as why and how people actually use these solutions and play these games. Even though the amount of studies focusing on the usage aspects of VR has increased recently, there is still a dearth of understanding on the usage of VR games and VR arcades. The understanding of these issues is essential especially for the designers, developers, and marketers of VR games and entertainment in terms of providing users of different demographic backgrounds such VR gaming and entertainment solutions that they really want to use. Thus, subsequently advancing the diffusion and adoption of VR technologies. In addition, considering the exergaming [4,5] character of VR gaming (especially in VR arcades), VR gaming can also be considered as a potential way to fight the problems of sedentary lifestyle, which are becoming increasingly widespread in the society. Indeed, popular VR exergames such as Soundboxing [6] and Beat Saber [7] have received a lot of praise for their ability to provide physical activity [e.g., 8].

This study addresses the aforementioned research gap concerning the users and usage habits of VR arcades and VR gaming. More precisely, this study takes an exploratory approach to investigate the habits of using VR arcades with emphasis on digital gaming, and focuses particularly on the differences between gender, age, and physical activity background. The main research questions that the study aims to answer are:

1. What are the typical habits of using VR arcades and digital games in VR arcades?

2. What kinds of gender, age, and physical activity background differences exist in the habits of using VR arcades and digital games in VR arcades?

In order to answer these questions, a quantitative study was conducted by collecting and analyzing data on the users' demographics, physical activity background, and the habits of using VR arcades. In this study, physical activity background refers to categories including aspects of physical activity level and the main purpose of conducting physical activity. This study followed an exploratory approach, meaning that the habits of using VR arcades were examined at a descriptive level without utilizing any prior theoretical framework. The study brings new knowledge to this interesting subject, and thus, extends our understanding on digital gaming and entertainment use in VR arcades. As a practical contribution, the findings are used to present implications for VR gaming and VR arcade stakeholders.

2 Background

As this study is exploratory in nature, any *a priori* hypotheses on how gender, age, and physical activity background are expected to be associated with the habits of using VR arcades (e.g., linear – non-linear or positive – negative) are not proposed. However, these kinds of relationships are expected to exist based on the findings of prior research on the differences in gaming related factors between genders, age groups, and physical activity backgrounds [9,10,11,12,13,14,15,16,17,18,19]. For example, [18] found that gender differentiates the perceived level of hedonic and utilitarian value of digital games: Most notably, males value greatly more games that are masculine and females give higher value to such game subcategories as professions, real-life simulation, and educative games. [16] found that there are differences between age groups in types of games played, social setting of playing, the used technologies, and the perceived importance of certain game features such as artwork, storyline, rewards, fantasy themes, and competitive multiplayering. [13] found differences between people with different physical activity backgrounds regarding the exertion level of playing exergames: the more physically active group the person belonged to, the more likely he or she was to mainly play at a light exertion level.

Furthermore, the innovation diffusion theory [20] states that, among other factors, socioeconomic characteristics (e.g., age and gender) and personality variables (e.g., physical activity background) influence the adoption and use of an innovation. This study focuses particularly on the habits of using VR arcades with emphasis on digital gaming. Habit, in this study, refers to the different ways people use VR arcades (e.g., forms of entertainment, purpose, social setting, and physical exertion). Similar conceptualization of habit has been previously used, for example, by [21] and [22].

2.1 Virtual Reality Arcades

VR arcades can be categorized based on the technology they use and provide. For one, there are VR arcades that provide VR headsets (often tethered, as standalone headsets were still relatively uncommon early 2019) with their controllers, such as the HTC

VIVE or the Oculus RIFT. These are typically used by utilizing six-degrees-of-freedom motion tracking so that the user can move around in a space of approximately 15 square meters. Another typical type of VR arcades are the ones that provide, in addition to the headsets, different kinds of VR motion platforms, such as the Virtuix Omni. These motion platforms, also sometimes called VR treadmills, typically allow for omnidirectional walking and running on the platform. This enables the user to move within the virtual world environment by actually using their legs. Third typical type of VR arcades are those that offer free-roam VR experiences, for example, the Zero Latency VR arcades. Free-roam VR uses either standalone headsets or headsets connected to backpacks (with computers in them) that the users carry with them while playing. Free-roam VR frees the users from cables and other stationary equipment and allows them to move freely in a designated area that is usually set or build into a warehouse or similar large space, where the users have a rather large area to roam around.

Aforementioned typical VR arcade solutions offer novel opportunities for digital gaming and other forms of entertainment, and the available solutions present a wide mix of games and entertainment. Research has shown that VR games can provide heightened experiences, a higher degree of flow, a richer engagement with passive game elements, and a deeper immersion [23]. They also often provide some level of physical exertion to the users, bringing VR games close to the concept of exergaming [4,5]. Exergaming can be characterized as a form of digital gaming that requires physical effort from the player in order to play the game and which determines the outcome of the game [4]. Due to this exergaming character of VR gaming, the physical activity background is also investigated.

VR also has its limitations and the developers are dealing with a number of issues to be solved. These issues are mostly not directly related to VR arcades but VR in general. For example, using VR can cause cybersickness (i.e., nausea, disorientation or similar symptoms) to some people. Also, as wearing a VR headset typically prevents seeing the physical world, the user can accidentally hit or run into walls, furniture, or other people. From a more technical perspective, [24] found that issues such as bugs, quality of graphics, and too complex controls can lead to negative user experiences.

Whereas previous research on the use of VR arcades is almost non-existent, various studies have been conducted on VR in general. Studies' perspectives range from more technology focused approaches to more user-centric approaches. As an example of a technology focused approach, [e.g., 25] have studied redirected walking, that is, steering algorithms that continuously redirect the user in order to make the virtual environment larger than the available physical space. As an example of a more user-centric approach, [e.g., 23] have studied player experiences of VR gaming.

3 Methodology

The data for this study were collected in two ways. First, an online survey was administered among Finnish consumers. Second, the author spent two separate days in a virtual reality arcade and collected data with survey forms. Online survey was selected for the main data collection method because of its effectiveness in gathering quantitative

data for the purpose of this study. The online survey was created by using the LimeSurvey 3.15.8 software. Before the survey was launched, the questionnaire was pre-tested qualitatively with four game and information systems researchers to ensure that the questions effectively captured the topic under investigation. Based on the discussions and feedback, some minor modifications were made. The final survey questionnaire was online for two months during November 2018 – January 2019. During this period, the online survey was promoted by handing out invitation leaflets in three different VR arcades (all offered both games and other forms of entertainment) and by posting a survey link to a few Finnish discussion forums focusing on VR and/or digital gaming. To increase the response rate, the respondents who completed the online survey could choose to take part in a raffle of four gift cards to a collaborating VR arcade. The two data collection days in VR arcade took place during and after the online survey. Whereas the online survey also collected data for a purpose of another study, the forms only consisted the questions relevant for this study. The surveys were targeted for people who had at least some experience with VR arcades and could thus give responses based on actual usage.

The studied habits were selected based on previous literature [11,12,13]. Similarly, the questionnaire sections used in this study were adapted from previous literature [11,12,13] and focused specifically on the respondents' demographics, physical activity background, and habits of using VR arcades. The questions in the habit section are presented in Appendix A (translated from Finnish to English).

The descriptive questions about the habits of using VR arcades were all closed-ended multiple choice questions and investigated: a) the main form of entertainment used in VR arcades (games, other entertainment, both), b) the main purpose of visiting VR arcades (fun, utility, both), c) the main social setting of visiting VR arcades (alone, together with others but single play / use, together with others and multiplayer / use), d) the main physical exertion level of playing (light, moderate, vigorous), e) the main physical exertion level of using other forms of entertainment (light, moderate, vigorous), and f) the perceived effects of using VR arcades on physical fitness (negative, no effects, positive). To avoid forced responses, the respondents also had the option "cannot say" with these questions.

The descriptive questions on the demographics and physical activity background were closed-ended multiple-choice questions. The question concerning the physical activity background was based on the 2009–2010 Finnish National Sport Survey [26] and included the following answer options (ordered from the highest physical activity level to the lowest physical activity level): competitive athlete, recreational sportsman, physically active for fitness, physically active for health, active in commuting and non-exercise, occasionally active, and sedentary. The respondents were asked to state which type of physically active person they see themselves to be by selecting between these seven categories. Each category was presented with a description. The categories are explained in more detail in Appendix B (translated from Finnish to English).

The data was analyzed with the IBM SPSS Statistics 24 software. The statistical significance and the strength of the dependencies between the responses and gender, age, and physical activity background were analyzed through contingency tables (cross-

tabs), the Pearson’s χ^2 tests of independence, and the Cramér’s V coefficients. The respondents who could not state their physical activity background as well as those who answered “cannot say” to the habit questions were excluded from the respective analysis. In some cases, the common condition “No more than 20% of the expected counts are less than 5 and all individual expected counts are 1 or greater” for the validity of χ^2 test [27, p. 734] was not met. Hence, following the widely used guidelines by [28] and [29], the results of the Pearson’s χ^2 tests of independence were advanced by using (Monte Carlo) exact tests. Monte Carlo [30] test was based on 10 000 sampled tables and a 99 % confidence level. This procedure is considered reliable and independent of the dimension, distribution, allocation, and the balance of the analyzed data [30]. The level of significance was set to 0.05. These methods enabled to examine both the linear and the non-linear dependencies, which suited well the study’s exploratory nature.

4 Results

The surveys yielded a total of 130 responses (76 from the online survey and 54 from the survey forms), out of which 126 were valid and included in the analysis. As the survey was promoted for those who had experience of using VR arcades, almost all respondents had such experience. There was one respondent who stated to have visited VR arcades zero times yet still answered the survey. This respondent was removed from the analysis together with three others who showed content non-responsivity by responding similarly to all questions [31]. Descriptive statistics concerning gender, age, and physical activity background of the analysis sample are presented in Table 1.

Table 1. Descriptive statistics of the sample.

	Sample (N = 126)	
	n	%
Gender		
Male	74	58.7
Female	52	41.3
Other	0	0.0
Age		
–19 years	9	7.1
20–29 years	40	31.7
30–39 years	46	36.5
40– years	31	24.6
Physical Activity Background		
Competitive athlete	5	4.0
Recreational sportsman	11	8.8
Physically active for fitness	38	30.4
Physically active for health	30	24.0
Active in commuting and non-exercise	23	18.4
Occasionally active	18	14.4
Sedentary	0	0.0
N/A	1	–

In terms of gender, out of the 126 respondents, 58.7 % identified themselves as males and 41.3 % as females. According to the 2018 Finnish Player Barometer [14], digital gaming (80.1 % vs. 72.0 %) as well as gaming with VR platforms (8.8 % vs. 4.0 %) is more popular among males than females in Finland. The mean age of the respondents was 32 years (SD = 9.3 years, Median = 32.0), which is not far from the mean age of digital game players in Finland (38.2 years) [14]. Regarding the physical activity background, the distribution was reasonably close to that of Finnish National Exercise Survey [26]. Overall, the sample can be seen as representative. Out of all the respondents, only 14 (11.1 %) owned virtual reality devices themselves. This indicates that for the most, VR arcades are the most accessible option to consuming VR games and entertainment. In line with this, the 2018 Finnish Player Barometer reported that only 6.7 % of Finns have ever tried playing with VR platforms and the amount of active (at least once a month) VR players is 1% [14].

4.1 Habits of Using Virtual Reality Arcades

The responses to the six descriptive questions about the habits of using VR arcades are summarized in Table 2. The responses suggest the following: In terms of the form of entertainment used in VR arcades, most respondents (64.3 %) mainly played games, whereas 8.7 % mainly used other forms of entertainment, and 27 % mainly used both games and other forms of entertainment when visiting VR arcades.

Regarding the purpose of using VR arcades, for the vast majority (91.3 %), the main purpose to visit VR arcades was fun. For 3.2 % the main purpose was utility related (e.g., exercise or other utility), and for 5.6 % the main purpose was both fun and utility combined.

In terms of social setting, it was much more popular to visit VR arcades together with others than alone. 14.4 % mainly visited alone, whereas 85.6 % mainly visited with others. Out of those who mainly visited with others, 54.2 % also mainly played or used the VR in a multiplayer/multiuser mode, whereas 45.8 % still mainly played or used the VR alone.

Regarding the exertion level in VR arcades, playing is clearly conducted with more physical intensity than other forms of entertainment. Of the respondents, 58.3 % played with mainly moderate and 5 % with mainly vigorous exertion level, whereas other forms of entertainment were mainly consumed with light (79 %) exertion level. Concerning the effects to physical fitness, most users perceived the use of VR arcades to not have had significant effects.

Table 2. The habits of using virtual reality arcades among the respondents.

	Sample (N = 126)	
	n	%
Form of entertainment		
Games	81	64.3
Other entertainment	11	8.7
Both	34	27.0
N/A	0	–

Purpose of using		
Fun	115	91.3
Utility	4	3.2
Both fun and utility	7	5.6
N/A	0	–
Social setting		
Alone	18	14.4
Together with others – single play / use	49	39.2
Together with other – multiplayer / use	58	46.4
N/A	1	–
Exertion level of playing		
Light	44	36.7
Moderate	70	58.3
Vigorous	6	5.0
N/A	6	–
Exertion level of other entertainment		
Light	79	79.0
Moderate	21	21.0
Vigorous	0	0.0
N/A	26	–
Effects to physical fitness		
Negative	1	0.9
No significant effect	101	93.5
Positive	6	5.6
N/A	18	–

4.2 Gender

Table 3 summarizes the results of the Pearson's χ^2 tests of independence that were used to examine the statistical significance and strength of the dependencies between gender and the responses.

Table 3. Gender dependencies.

	n	χ^2	df	p	p (Monte Carlo)	V
Form of entertainment	126	11.342	2	0.003	0.003	0.300
Purpose of using	126	0.602	2	0.740	0.795	0.069
Social setting	125	13.919	2	0.001	0.001	0.334
Exertion level of playing	120	2.897	2	0.235	0.238	0.155
Exertion level of entertainment	100	0.669	1	0.414	0.467	0.082
Effects to physical fitness	108	1.951	2	0.377	0.514	0.134

The habits in which there was a statistically significant dependency with gender were form of entertainment ($\chi^2(2) = 11.342$, $p = 0.003$, $V = 0.300$) and social setting ($\chi^2(2) = 13.919$, $p = 0.001$, $V = 0.334$).

When visiting VR arcades, males mainly played games more compared to females, whereas females mainly used also other forms of entertainment more compared to males. Of the 74 male (m) respondents and 52 female (f) respondents, 74.3 % (m) and 50 % (f) stated to be mainly playing games in VR arcades, 23 % (m) and 32.7 % (f)

stated to be mainly using both games and other forms of entertainment, and 2.7 % (m) and 17.3 % (f) stated to be mainly using other forms of entertainment.

Males visited VR arcades alone more compared to females. Interestingly, while females visited VR arcades more together with others, males visiting together with others more often also played games or used entertainment together with others, whereas females more often played games or used entertainment alone even when visiting together with others. Of the 74 male and 51 female respondents, 17.6 % (m) and 9.8 % (f) stated to be mainly visiting VR arcades alone, 25.7 % (m) and 58.8 % (f) stated to be mainly visiting VR arcades together with others but playing games or using entertainment alone, whereas 56.8 % (m) and 31.4 % (f) stated to be mainly visiting VR arcades together with others and also playing games or using entertainment with others.

4.3 Age

Table 4 summarizes the results of the Pearson's χ^2 tests of independence that were used to examine the statistical significance and strength of the dependencies between age and the responses.

Table 4. Age dependencies.

	n	χ^2	df	p	p (Monte Carlo)	V
Form of entertainment	126	20.373	6	0.002	0.003	0.284
Purpose of using	126	4.116	6	0.661	0.681	0.128
Social setting	125	25.826	6	< 0.001	< 0.001	0.321
Exertion level of playing	120	4.380	6	0.625	0.629	0.135
Exertion level of entertainment	100	4.620	3	0.202	0.208	0.215
Effects to physical fitness	108	17.159	6	0.009	0.014	0.282

The habits in which there was a statistically significant dependency with age were form of entertainment ($\chi^2(6) = 20.373$, $p = 0.003$, $V = 0.284$), social setting ($\chi^2(6) = 25.862$, $p < 0.001$, $V = 0.321$), and effects to physical fitness ($\chi^2(6) = 17.159$, $p = 0.014$, $V = 0.282$).

In all investigated age groups, people mainly played games when visiting VR arcades. However, it was more common the younger the age group was. In contrast, using mainly other forms of entertainment when visiting VR arcades was more common the older the age group was.

People in the age group 30–39 visited VR arcades alone more than the people in the two younger and the oldest age groups when compared. Interestingly, when visiting VR arcades together with others, people in the youngest and the oldest age group still mainly played games or used entertainment alone, whereas people in the age groups 20–29 and 30–39 also mainly played games or used entertainment together with others.

Regarding the effects to physical fitness, the most common perception in all age groups was that using VR arcades had not affected their physical fitness significantly. However, the perception of improved physical fitness due to using VR arcades was

clearly higher in the youngest age group (33 %) compared to the other age groups (2.8 %, 5.1 %, and 5,6%).

4.4 Physical Activity Background

Table 5 summarizes the results of the Pearson's χ^2 tests of independence that were used to examine the statistical significance and strength of the dependencies between physical activity background and the responses.

Table 5. Physical activity background dependencies.

	n	χ^2	df	p	p (Monte Carlo)	V
Form of entertainment	125	13.564	10	0.194	0.190	0.233
Purpose of using	125	12.868	10	0.231	0.212	0.227
Social setting	124	10.763	10	0.376	0.382	0.208
Exertion level of playing	119	4.298	10	0.933	0.948	0.134
Exertion level of other entertainment	100	15.124	5	0.010	0.012	0.389
Effects to physical fitness	107	9.918	10	0.448	0.381	0.215

The only habit in which there was a statistically significant dependency with physical activity background was *exertion level of other entertainment* ($\chi^2(5) = 15.124$, $p = 0.012$, $V = 0.389$).

Using other forms of entertainment was most commonly conducted with light exertion level in all physical activity groups except recreational sportsman, in which the use was divided equally between light and moderate exertion levels. Overall, it can be said that the physical activity background had a very small influence on the habits of using VR arcades.

5 Discussion and Conclusions

This study explored the habits of using VR arcades with emphasis on digital gaming. Specific focus was set on investigating differences between gender, age, and physical activity background. The main purpose of the study was to find out 1) What are the typical habits of using VR arcades and digital games in VR arcades? and 2) What kinds of gender, age, and physical activity background differences exist in the habits of using VR arcades and digital games in VR arcades?. The study followed an exploratory and quantitative approach.

The main findings concerning the habits of using VR arcades show that digital gaming is clearly the most popular form of entertainment in VR arcades. Further, for the vast majority, the main purpose to visit VR arcades is fun, and purely utility related purposes are quite uncommon. This does not mean that the users would not perceive also utilitarian benefits from using VR arcades, but tells that the main purpose for using is fun. From a practical standpoint, this implies that VR arcades should develop and market their offering by using fun and amusement as a spearhead. Further, VR game

designers who design VR games for physical activity or other utilitarian purposes, should also pay close attention to the fun aspect of the games.

In terms of the social setting, it is much more popular to visit VR arcades together with others than alone. Interestingly though, almost half of the respondents who visited VR arcades together with others used the games and entertainment alone. This suggests that VR gaming in VR arcades, or VR games in general, perhaps do not support multiplaying at a sufficient level. Thus, designers of VR games could provide more opportunities for gaming that is specifically designed to support good multiplayer experiences, for example by designing games that can be played by two or more players simultaneously each player wearing their own headset. VR arcades should also contemplate whether their offering has suitable multiplayer games and implement more such games into use. VR arcades should also market the available multiplayer opportunities more.

The findings also show that gaming compared to other forms of entertainment in VR arcades is conducted with a much more physically intensive level. Also, as over half of the respondents reported to be mainly playing with moderate exertion level, it shows that VR gaming can provide adequate intensity for physical activity as advised in the global physical activity recommendations [32]. Thus, it can potentially have positive health outcomes in that sense. Even though most of the respondent did not perceive notable changes in their physical fitness, the potential of VR gaming is still notable and worth to consider when planning physical activity promotion campaigns. This also demonstrates that VR gaming can be a new frontier for exergaming and suggest that users would welcome games that offer physical exertion. From a practical standpoint, this gives a signal to the designers of VR games to include physical movements and exertion in the games.

Regarding gender differences, the findings show that while gaming is the most popular form of entertainment in VR arcades for both represented genders, when compared, males mainly play games more, whereas females mainly use more also other forms of entertainment. This suggests that females might be more open to VR experiences that do not involve gaming actions per se. From a practical perspective, this implies that designers of VR games could perhaps provide more such (non-gaming) VR entertainment that would potentially attract the female audience specifically. This finding could also be utilized in marketing, for example, females might be a more potential target group for VR marketing messages that illustrate how one can “just relax” in VR. Furthermore, VR arcades should make sure that they provide both gaming and other VR entertainment options.

Regarding age differences, the most notable finding was that although people mainly play games when visiting VR arcades in all investigated age groups, it is more common the younger the age group is. In contrast, using mainly other forms of entertainment when visiting VR arcades is more common the older the age group is. For practitioners, this suggests that age is a factor that should be taken into account when designing content and interactions for VR experiences as well as when marketing VR gaming and experiences to different age groups, in particular, when the target group is of certain age.

Regarding the relationships between physical activity background and habits of using VR arcades, the findings show that there are not many differences in usage habits between people with different physical activity backgrounds. But when examining the

distribution of physical activity backgrounds among the respondents, it shows that most were in the “medium” categories *active for health* and *active for fitness*, whereas those in the most and the least active categories comprised a much smaller proportion. However, this also follows and could be due to the distribution of Finnish people’s physical activity backgrounds [26]. Nevertheless, it might be that when communicating specifically about the physical activity side of VR gaming, those with medium physical activity levels are perhaps the most potential target group. Further, if targeting the more active and the more inactive people, special focus and strategies need to be considered in order to be successful. For example, marketing messages could be specifically tailored for those who are very active and for those who are rather inactive.

To conclude, the main contribution of the study is the new knowledge and understanding on digital gaming and entertainment use in VR arcades, and on the differences between different user groups. As a practical contribution, the designers, developers, and marketing people of VR gaming and VR arcades can use the findings and the presented implications in designing and developing more captivating VR games and VR arcade experiences, which would be better accepted by the users and would gain more success in the market, thus advancing their acceptance and diffusion.

6 Limitations and Future Research

This study has three notable limitations. First, the operationalization of some of the surveyed concepts (e.g., the purpose, social setting, exertion level, and perceived effects of playing) was done in a relatively simplistic manner, as they were measured with single-item measures. These measures also focused on subjective perceived measures rather than on objective measures of the concepts. Hence, future research could benefit from measuring the concepts with multiple questions, thus also allowing to evaluate the reliability and validity of the measures. Future studies could also examine the relationships between the concepts, which was not done in this study. Second, the data grouping used in this study is only one way to examine the gathered data. Future studies could use other criteria for the data grouping, for example, based on other demographics, and thus, provide additional insights on the role of relevant background factors for digital gaming and entertainment use in VR arcades. Third, as the study was conducted in Finland and the survey administered in Finnish, it limits the generalizability of the findings. The results might differ in some other gaming cultures, which is something for future studies to investigate. In addition, scholars can draw from this study in designing their studies. They could also benefit from using alternative data collection methods, such as qualitative interviews, and from using other data analysis methods.

References

1. Sherman, W. R., Craig, A. B.: Understanding virtual reality: interface, application, and design. Morgan Kaufmann, Cambridge, MA (2018).
2. Forbes, VR Wave Breaking Outside The Home, <https://www.forbes.com/sites/charliefink/2018/05/28/vr-wave-breaking-outside-the-home/#67259296770e>, last accessed 2019/07/06.

3. Venturebeat, VR arcades are playing a leading role in the consumer market, <https://venturebeat.com/2018/07/05/vr-arcades-are-playing-a-leading-role-in-the-consumer-market>, last accessed 2019/07/06.
4. Kari, T., Makkonen, M.: Explaining the usage intentions of exergames. In: Proceedings of the 35th International Conference on Information Systems, pp. 1-18. Association for Information Systems (AIS), Auckland, New Zealand (2014).
5. Mueller, F., Khot, R. A., Gerling, K., Mandryk, R.: Exertion games. *Foundations and Trends® in Human-Computer Interaction* 10(1), 1–86 (2016).
6. Maxint LLC, Soundboxing, <https://www.soundboxing.co>, last accessed 2019/07/11.
7. Beat Games, Beat Saber, <https://beatsaber.com>, last accessed 2019/07/11.
8. VR Fitness Insider, Job Stauffer’s Story About Losing 60 pounds and Reclaiming His Health with VR, <https://www.vrfitnessinsider.com/job-stauffers-story-losing-60-pounds-reclaiming-health-vr>, last accessed 2019/07/11.
9. Bonanno, P., Kommers, P. A.: Gender differences and styles in the use of digital games. *Educational Psychology* 25(1), 13-41 (2005).
10. Hoeft, F., Watson, C. L., Kesler, S. R., Bettinger, K. E., Reiss, A. L.: Gender differences in the mesocorticolimbic system during computer game-play. *Journal of Psychiatric Research* 42(4), 253–258 (2008).
11. Kari, T., Makkonen, M., Moilanen, P., Frank, L.: The habits of playing and the reasons for not playing exergames: gender differences in Finland. In: Proceeding of the 25th Bled eConference, pp. 512–526. University of Maribor, Bled, Slovenia (2012).
12. Kari, T., Makkonen, M., Moilanen, P., Frank, L.: The habits of playing and the reasons for not playing exergames: age differences in Finland. *International Journal on WWW/Internet* 11(1), 30–42 (2013).
13. Kari, T.: Explaining the adoption and habits of playing exergames: the role of physical activity background and digital gaming frequency. In: Proceedings of the 21st Americas Conference on Information Systems, pp. 1–13. Association for Information Systems (AIS), Fajardo, Puerto Rico (2015).
14. Kinnunen, J., Lilja, P. Mäyrä, F.: Finnish player barometer 2018 [Pelaajabarometri 2018], (Report). University of Tampere, Tampere, Finland (2018).
15. Liu, C. C.: Understanding player behavior in online games: the role of gender. *Technological Forecasting and Social Change* 111, 265–274 (2016).
16. Salmon, J. P., Dolan, S. M., Drake, R. S., Wilson, G. C., Klein, R. M., Eskes, G. A.: A survey of video game preferences in adults: building better games for older adults. *Entertainment Computing* 21, 45–64 (2017).
17. Schwarz, A., Mertens, L., Simons, M., Spook, J. E., Thompson, D., Cardon, G. ... DeSmet, A.: Which game narratives do adolescents of different gameplay and sociodemographic backgrounds prefer? a mixed-methods analysis. *Games for Health Journal* 8(3), 1–10 (2018).
18. Storgards, J. H., Sokura, B.: The role of gender in the hedonic and utilitarian value of digital games.” In: Proceedings of the 15th Americas Conference on Information Systems, pp. 1–9. Association for Information Systems (AIS), San Francisco, CA (2009).
19. Wilhelm, C.: Gender role orientation and gaming behavior revisited: examining mediated and moderated effects. *Information, Communication & Society* 21(2), 224–240 (2018).
20. Rogers, E. M.: *Diffusion of innovations*. 5th edn. Free Press, New York, NY (2003).
21. Böhler, E., Schüz, J.: Cellular telephone use among primary school children in Germany. *European Journal of Epidemiology* 19(11), 1043–1050 (2004).
22. Komulainen, J., Takatalo, J., Lehtonen, M., Nyman, G.: Psychologically structured approach to user experience in games. In: Proceedings of the 5th Nordic Conference on Human-Computer Interaction: Building Bridges, pp. 487–490. ACM, Lund, Sweden (2008).

23. Tan, C. T., Leong, T. W., Shen, S., Dubravs, C., Si, C.: Exploring gameplay experiences on the oculus rift. In: Proceedings of the 2015 Annual Symposium on Computer-Human Interaction in Play, pp. 253–263. ACM, London, UK (2015).
24. Farič, N., Potts, H. W., Hon, A., Smith, L., Newby, K., Steptoe, A., Fisher, A.: What players of virtual reality exercise games want: thematic analysis of web-based reviews. *Journal of Medical Internet research* 21(9), e13833 (2019).
25. Thomas, J., Rosenberg, E. S.: A General reactive algorithm for redirected walking using artificial potential functions. In: Proceedings of the 2019 IEEE Conference on Virtual Reality and 3D User Interfaces, pp. 56–62. IEEE, Osaka, Japan (2019).
26. Finnish Sports Federation.: National Exercise Survey 2009–2010 [Kansallinen Liikuntatutkimus 2009–2010]. Finnish Sports Federation, Helsinki, Finland (2011).
27. Yates, D., Moore, D., McCabe, G.: *The Practice of Statistics*. 1st edn. W.H. Freeman, New York, NY (1999).
28. Cochran, W. G.: Some methods of strengthening the common chi-square tests. *Biometrics* 10, 417–451 (1954).
29. Agresti, A.: *Categorical data analysis*. Wiley, New York, NY (2002).
30. Mehta, C. R., Patel, N. R.: *IBM SPSS exact tests*. IBM Corporation, Cambridge, MA (2012).
31. Meade, A. W., Craig, S. B.: Identifying careless responses in survey data. *Psychological Methods* 17(3), 437–456 (2012).
32. World Health Organization.: *Global recommendations on physical activity for health*. World Health Organization, Geneva, Switzerland (2010).

Appendix A. Usage Habits in VR Arcades Questions

1. When you visit virtual reality arcades, do you mainly use games or other forms of entertainment?

- Games
- Other forms of entertainment
- Both equally
- Cannot say

2. Do you visit virtual reality arcades mainly for fun or for utility?

- For fun
- For exercise utility
- For other utility
- Both for fun and utility
- Cannot say

(In the analysis, the options ‘For exercise utility’ and ‘For other utility’ were combined)

3. Do you visit VR arcades mainly alone or together with other people?

- Alone
- Together with other people but we use games and other entertainment alone
- Together with other people and we use games and other entertainment together (multiplayer games and similar)
- Cannot say

4. At what physical exertion level do you mainly play games in VR arcades?

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

5. At what physical exertion level do you mainly use other forms of entertainment in VR arcades?

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

6. How do you perceive that the use of VR arcades has affected your physical fitness?

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

(In the analysis, the two 'Negatively' answers and the two 'Positively' answers were combined as one 'Negatively' and one 'Positively' answers).

Appendix B. Physical Activity Background Question**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