

Understanding Senior Users' Needs, Preference, and Experience In Commercial Exergames for Health: Usability Study

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Understanding Senior Users' Needs, Preference, and Experience In Commercial Exergames for Health: Usability Study

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Abstract

Background: Exercise games, so-called exergames, drastically became popular during the lockdown of the COVID-19 pandemic when people had to stay at home. Many senior adults are at risk of acquiring mental and physical conditions due to the lack of sufficient exercise. So, promoting adherent exercise is an urgent issue to improve senior adults' muscle strength to prevent falls and conditions caused by physical and cognitive decline. Off-the-shelf exergames are mainly targeted at the younger generation or children; however, senior adults are neglected in the market, while doing exercise is strongly needed for this age group. Exergames could serve as a health intervention for promoting exercise.

Objective: The aim of this study is to investigate older adults' experience, perceptions, and acceptance of game technology to promote exercise in order to suggest game design guidelines.

Methods: Participants engaged in playing Nintendo Switch and Xbox Kinect games, after which semi-structured interviews were conducted for this usability study. Before the gameplay, a questionnaire of individual information and technology use habits was conducted. All participants completed a three-session workshop. Every session was conducted for two hours a day for three days. Before playing the games, participants provided their background information, exercise habits, and use of technology products. Following this, participants were involved in playing the latest Nintendo Switch games including Just Dance, Boxing, and Ring Fit Adventure as well as an Xbox game, Kinect Adventures. Participants were given brief instructions on how to play the games before each session. The participants played Switch's Just Dance and Boxing in the first session, Ring Fit Adventure and Mini-Games in the second session, and Xbox's Adventure in the third session. The observation was conducted by the researcher while participants were playing exergames. Each session began with brief instructions on the session activity for 20 minutes, followed by playing the selected exergames for 80 minutes, then a 20-minute semi-structured interview.

Results: Twenty-two participants (70.4 ± 6.1 years) were enrolled to the workshop in May 2021. The reflexive thematic analysis was applied to identify the relative themes emerged from the interview. The emerged themes include incomprehension of game instructions, playing difficulties due to memory & reaction, confusion caused of complicated interface, frustration caused by fast game speed, a sense of control and freedom, psychological perception of game technology, social interaction, as well as game art preferences. The emerged subtheme is game art preferences which include favorite game genres, characters, and scenes.

Conclusions: The study revealed that customized game tutorials are strongly needed, considering older adults' cognitive and physical ageing. Furthermore, the game genre of adventure is preferable than other games. Human-alike game characters are preferable especially in a fit and healthy body shape. Nature scenes in games are more enjoyable than indoor stages or rooms. Furthermore, the design of game intensity and playing time could be carefully planned to meet the criteria of WHO recommendation for physical activity in older adults. Intelligent recommendation systems might be helpful to support older adults in various health conditions. The guidelines suggested in this study might be beneficial for game design, exercise training, and game technology adoption of exergames for older adults to improve health.

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Original Manuscript

Original Paper

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Abstract

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Results: Twenty-two participants (70.4 ± 6.1 years) were enrolled to the workshop in May 2021. The reflexive thematic analysis was applied to identify the relative themes generated from the interview. The distinguished result of generated themes includes incomprehension of game instructions, psychological perception of game technology as well as game art preferences. The subthemes generated from game art preferences include favorite game genres, characters, and scenes.

Conclusions:

The study revealed that customized game tutorials are strongly needed, considering older adults' cognitive and physical ageing. Furthermore, the game genre of adventure is preferable than other games. Human-alike game characters are preferable especially in a fit and healthy body shape. Nature scenes in games are more enjoyable than indoor stages or rooms. Furthermore, the design of game intensity and playing time could be carefully planned to meet the criteria of WHO recommendation for physical activity in older adults. Intelligent recommendation systems might be helpful to support older adults in various health conditions. The guidelines suggested in this study

might be beneficial for game design, exercise training, and game technology adoption of exergames for older adults to improve health.

Keywords: Exergame; Senior user experience; Senior technology acceptance; Game technology; Psychological perception.

Introduction

The rapid growth of the aging population has drastically increased the needs of medical and healthcare services. Life expectancy is getting longer; however, the average life in a state of good health, so called healthy life expectancy, is almost 8-10 years less than life expectancy [1,2]. It is very important to increase healthy life expectancy for active aging and reduce the financial burden on health systems caused by incapacitation, bedridden patients, and chronic or mental health conditions. The World Health Organization (WHO) has suggested adults aged 65 and above to do 150-300 minutes of moderate intensity or 75-150 minutes of strenuous intensity aerobic physical activity in a week in order to improve physical and functional health and lower the risk of noninfectious chronic illness and mental health conditions [3]. However, it has been reported that 33.8% of older adults in the age group of 65-74 years old and about 36% of 55-64 year old “graying” adults did not do exercise at all in Taiwan [4]. Many “graying” adults in Taiwan are at risk of acquiring mental and physical conditions due to the lack of sufficient exercise. Therefore, providing preventive healthcare and promoting adherent exercise is an urgent issue to improve senior adults’ muscle strength and physical fitness to prevent falls and conditions caused by physical and cognitive decline.

Studies of Exergames for Health

Several studies have highlighted the benefits and positive impact of exergames on overall health. “Exergame” is the term most frequently used by health-related researchers to indicate video games that use strength training, balance, or flexibility [5]. Exergaming has gained public and commercial interest due to its combination of fun and fitness together, and is particularly popular for obesity-related intervention [6]. Furthermore, it has been regarded as future of fitness to maintain regular activity as it is a healthy, appealing alternative to other physical activity especially during the quarantine [7]. In addition to increasing physical exercise, exergaming could also be beneficial for psychological, cognitive, or psychosocial issues [8]. Exergames have been gradually applied in psychological treatment or physical rehabilitation for senior adults. For example, some studies have adopted exergames in psychological treatment for cognition [9], dementia [10], and depression [11]. Exergames have also been adapted for physical treatment to improve physical skills or fitness [12, 13], balance [14, 15], fall prevention [16], or rehabilitation [17,18,19]. Although there are many studies applying off-the-shelf exergames for mental and physical health and proof of their benefits and effectiveness, older adults’ perceptions, experiences, and expectations are rarely discussed. Therefore, it is important to investigate older adults’ experience and expectation of playing exergames as a preventive approach to promote exercise habits.

Exergame Technology

Exergames require players to interact with the virtual gameplay by means of their physical movements and gestures in the real world [20]. Exergames generally utilize motion-sensing technology which tracks and monitors players’ movement while performing game tasks by sensory devices, such as Nintendo’s Joy-Con or Microsoft’s Kinect. The motion-sensing technology differs between Nintendo and Xbox consoles. Nintendo Joy-Cons contain an accelerometer and gyroscope built into the device to track a player’s motion. Additionally, the Joy-Con also contains 3D touch technology, which provides subtle vibration feedback to players. On the other hand, Microsoft

Kinect, which is a camera-based and infrared depth-scanning approach device, enables a player to interact with the game by body movements. Various types of game consoles with different underlying body motion technology offer different user experiences, but the amount of physical efforts and energy to play exergames remains similar [21]. Accessibility and entertainability are the two distinguishing factors of exergames in promoting exercise and activity [22]. This study explored which interactive technology was preferred by older adults.

Technology Acceptance of Older Adults

For decades, many studies have researched how people adopt technology [23–26]. Davis [23] first developed the technology acceptance model to explain user behavior and the intention to use technology. Chen and Chan [26] further modified the model, calling their modified version the senior technology acceptance model, to learn about senior users' adoption of technology. "Older adults" generally refers to people whose chronological age is 60 years or over [27]. The researchers suggest that older adults' attitude toward using and intention to use technology are particularly affected by their self-efficacy, anxiety, health conditions, cognitive ability, social relationships, attitude toward life and satisfaction, physical functioning as well as the support of technology use they could receive around them. The senior technology acceptance model has been applied to understand older adults' behavior with regard to technology in Hong Kong [26], Sweden [28], and Taiwan [29].

According to a statistic survey from AARP foundation (The American Association of Retired Persons), 44 percent of older adults enjoy playing video games in the United States in 2019, while it was 38 percent in 2016 [30]. The growing population of older adults in game market shows that their needs should be taken into consideration in game design. However, many older adults may not have much experience of playing video games during their childhood, as computer-based video games became popular around the 1980s [31]. The target users of these exergames are mostly younger adults or children. The aging population is neglected in the market, while doing exercise is strongly needed for this age group. Therefore, this study investigated older adults' experience, perceptions, and acceptance of game technology to promote routine exercise.

Methods

This study was conducted with the approval of the Central Regional Research Ethics Committee China Medical University Taiwan. All participants were informed of the procedures involved in the study. They agreed to participate the study and signed the consent form. The inclusion criteria for the workshop and interview were participants aged over 60 years who could do exercise and understand the instructions given. The interview data was collected by audio recordings and was verbatim transcribed.

Thematic analysis which is a qualitative data analytic method was proposed by Braun and Clarke; they further clarify the approach and define as reflexive thematic analysis[32,33]. Reflexive thematic analysis is a common approach to identify, analyze, and report themes from qualitative datasets in content analysis and grounded theory [34]. Braun and Clarke have provided a six-phase steps process of the thematic analysis for researchers to conduct their qualitative studies [35], which are 1) familiarizing with the data, 2) generating initial codes, 3) searching for themes, 4) reviewing potential themes, 5) defining and naming themes, and 6) producing the report. The six-phase process is not a linear process, but an iteratively developing process which are flexible to tailor for the qualitative data [36].

Recruitment and Procedure

The workshop was conducted in a spacious classroom that had been transformed to accommodate

exergame testing. The classroom was large enough to ensure there were no obstacles to the participants performing their movements and gestures while playing the games. Four Sanlux 55-inch 4K Ultra HD TVs with Nintendo Consoles and Xbox Kinect consoles were set up in the classroom and each TV equipped with consoles was shared by two participants while playing selected exergames. The participants had sufficient space to move around and had full range of motion with the whole body. The classroom accommodated 6-8 participants in each workshop and three workshops were conducted in total.

Data Analysis

The qualitative data of the semi-structure interview was analyzed by thematic analysis in a six-step process. The details of the process are addressed in the following paragraph.

Phase 1 familiarizing with the data: the interview recordings were gathered and transcribed. During phase 1, the researcher immersed herself in the data by reading, rereading and making notes on manual transcript as well as noticed connections between participants, data and existing studies.

Phase 2 generating initial codes: the interview transcript was systematically analyzed through coding. Some codes stayed close with the participants' concepts and others aroused interpretation from the researcher in phase 2.

Phase 3 searching for themes: afterwards, all the coded data were identified and clustered into broader topics or themes based on their similarity and overlaps.

Phase 4 reviewing potential themes: all the generated themes were reviewed to check whether they worked meaningfully and relevantly with the coded data.

Phase 5 defining and naming themes: after reviewing possible themes, the identified themes were subsequently defined and labeled.

Phase 6 producing the report: these generated themes could answer the research questions of older adults' experience, perception and acceptance of adopting exergames for exercise.

Results

A total of 22 older adults aged 60 years and over were enrolled in this study. The participants' ages ranged from 60 to 82 years (Table 1), including 16 females and 6 males.

Table 1. Participant general information (n=22).

Participant information	Value
Age (years)	70.4 ± 6.1
Male (years)	68.7 ± 5.4 (n=6)
Female (years)	71.0 ± 6.4 (n=16)
Sex	
Male (%)	27.3 (n=6)
Female (%)	72.7 (n=16)
Education (years)	11.5 ± 4.5 (6-16)
BMI (Male) (kg/m ²)	23.3 ± 4.5
BMI (Female) (kg/m ²)	22.4 ± 2.8
Exercise routine	

Everyday	27.3 %
3-5 days a week	54.5 %
1-2 days a week	13.6 %
1-3 days a month	4.5 %
Exercise time	
> 30 minutes a day	72.7 %
20-30 minutes a day	18.2 %
10-20 minutes a day	4.5 %
< 10 minutes a day	4.5%
Exercise intensity	
Barely there	50 %
Moderate	45.5%
Harder	4.5%
Technology products using habits (Possession of the technology products: smart phones / tablets / computers)	
I do not have any of them	4.5 %
I have one of them	36.4 %
I feel comfortable of using them	59.1 %
Frequency of using the technology products	
Never	4.5 %
One time a week	13.6 %
2-3 times a week	0 %
Many times a week	4.5 %
One time a day	9.1 %
Many times a day	68.2 %
Experiences of playing videogames / digital games (arcade, home console, handheld game console, computer game, or online game)	54.5 %

* Data are mean $\pm$ SD.

All participants completed a workshop which included three activities (Figure 1). Every activity was conducted for two hours a day for three days. Before playing the games, participants provided their background information, exercise habits, and use of technology products. Following this, participants were involved in playing the latest Nintendo Switch games including Just Dance, Boxing, and Ring Fit Adventure as well as Xbox Kinect Adventures. Participants were given brief instructions on how to play the games before each activity. The participants played the Switch's Just Dance and Boxing in the first activity, Ring Fit Adventure and Mini-Games in the second activity, and Xbox's Adventure in the third activity. Each activity began with brief instructions for 20 minutes, followed by playing the selected exergames for 80 minutes, then a 20-minute semi-structured interview.



Figure 1. Participants played Boxing (left) and Ring Fit Adventure (right).

The background information of participants showed that only 31.8% of the participants might meet the criteria of WHO suggestions for weekly exercises. The participants were familiar with phone technology and often used it for social media, photography, Google searching or online shopping. Some of them had previous experience of playing video games. These results showed that the participants were less active individuals and comfortable using technology products.

Most participants did regular or mild exercise at light intensity; however, only few participants met the WHO criteria of older adult exercise. Multicomponent physical activity at moderate or higher intensity is recommended by WHO[3]; however, the result shows that the exercise intensity and time of older adults are not enough.

The semi-structured interviews raised topics relating to user experience, psychological perceptions, and the adoption of game technology. The transcript of the semi-structure interview was analyzed by thematic analysis in a six-step process. During phase 1, the researcher thoroughly examined the data by reading the manual transcript, and identified connections between participants, data, and existing studies. In the phase 2, the transcript was systematically analyzed through coding. For example, “the tutorial in the game were not clear and not easy to understand. It is better to have instructors to teach me how to operate the game” was coded that the game tutorials are not supportive, difficult to understand, and the participant might lose motivation to play. Afterwards, the coded data was grouped into larger themes based on how they were connected. For example, coded data such as ‘don’t know how to play’, ‘not understanding’, ‘forgot tutorials’ were clustered into “incomprehension of game instructions”. The identified themes were carefully reviewed to ensure they accurately and meaningfully represented the coded data in the phase 4. The themes were then defined and named as 1) incomprehension of game instructions, 2) confusion caused by complicated interface, 3) Frustration caused by fast game speed, 4) a sense of control and freedom, 5) psychological perception of game technology, 6) social interaction, and 7) preference of game art in the phase 5. These generated themes could answer the research questions of older adults’ experience, perception, and acceptance of adopting exergames for exercise. The generated themes and the participants’ feedback were shown in Table 2.

Table 2 Generated themes from the interview

Theme	Example	gender ^a , age, game experience ^b
(1) Incomprehension of game instructions (8 participants, 36.4%)		
	It is very critical that someone could guide us before playing games (Just Dance-Switch). Knowing how to	F,74, N.

	play motivates me to play the game.	
	I need someone next to me and tell me how to play.	F, 67, Y.
	I don't know how to play the game because I don't understand the game mechanics and rules.	M, 68, Y.
	I need a detailed game tutorial of the game to support me when playing the game.	F, 75, N
	The tutorial in the game is not clear and not easy to understand. It is better to have instructors to teach me how to operate the game. (Ring Fit Adventure)	M, 62, Y
	By the game instructions, I cannot fully understand what it means and how to play. I prefer someone (instructors) to teach me for better understanding.	M, 72, Y
	I can't remember things well. So, I forgot tutorials while playing. I might remember how to play after many times gameplay.	F, 79, Y
	I need more practice to remember how to play.	M, 76, Y
(2) Confusion caused by complicated interface (5 participants, 22.7%)		
	At the beginning, it was difficult to understand the game interface, but after practicing I got used to controlling it.	F, 66, N
	I don't know the meanings of the icons in the game interface.	F, 74, N M, 76, Y
	There is too much information on the screen, I don't know what to look at while playing (Fit Battles, Ring Fit Adventure).	F, 75, N
	The game interface was very complicated and difficult to use. I guess it is also difficult to control machines for most of the older adults (Just Dance-Switch) .	F, 63, N
(3) Frustration caused by fast game speed (8 participants, 36.4%)		
	I would give up and feel frustrated when I cannot keep up with the speed of the games.	F, 82, Y
	I wish I could control the speed of the game from slow to fast, so that I could participate in the game, not be excluded since the very beginning.	F, 63, N
	I was too slow in the response in the playing. For example, I wanted to jump and get the golden coin, but when I jumped the golden coin disappeared (Xbox-Adventure) .	F, 78, Y F, 75, N
	It is very difficult and complicated to do more than two actions at the same time. I have to avoid getting bombed and to get golden coins (Ring Fit Adventure).	F, 74, N
	I feel I am not as agile as I was. The game should provide different levels of difficulty for different age.	F, 79, Y
	After seeing the boxing icon showing up from the bottom of the screen, I need to punch at the right tempo. But I was always too late to react. I need some time to think and then do the action (Boxing).	F, 66, N
	The speed in the game was too fast for me. I think the game should provide different levels of difficulty or provide different levels according to different age groups	F, 79, Y

	(Boxing).	
(4) A sense of control and freedom (4 participants, 18.1%)		
	I like to use joystick to control games because of the tactile responses. Although I feel free when I don't need to hold anything to control the game. However, I don't receive tactile sensation feedback to know whether I did the correct movement or not (Xbox adventure).	F, 60, Y
	I like to use my body motion to control the game because I don't like to hold anything on hands. I don't know how to use joystick and I feel it is quite complicated. It is easy, free, and intuitive to control the game by my body.	F, 63, N
	I prefer the realistic feeling of pressing and dragging the Ring-Con. It gives me real feedback and is easy to use.	M, 71, N
	The vibration of the joystick gives me feedback of correct movement, and I like to receive the feedback (Boxing).	F, 74, N
(5) Psychological perception of game technology (9 participants, 40.9%)		
	Playing the games could make me keep focus, train my brain and coordination.	F, 66, N
	It is so much fun to do exercise by playing games. I didn't expect myself to enjoy doing exercises (Boxing, Xbox adventure).	M, 68, Y
	I prefer to play Boxing game because it is very challenging.	M, 62, Y
	I feel it is fashionable to play state of the art games, which could connect me and the younger generations.	F, 82, Y
	I feel I am keeping up with trends because I can operate game technology device and share with my grandchildren.	F, 74, N
	I didn't know games could so charming and interesting. It is a fresh experience, and it is quite fashion and trendy to play games for me.	F, 79, Y
	I would like to try new things, and I wish I could keep up with the times.	F, 74, N
	I was afraid of new technology in general. I don't know how to use them. But if I have a chance to approach it and someone could teach me, I will be happy to learn.	F, 60, Y
	I feel video games are not for us, it is for the youth.	F, 82, Y
(6) Social interaction (5 participants, 22.7%)		
	It has become a common interest between me and my grandchildren. We can play together, and we have common topics to talk about.	F, 75, N
	Collaborating with other players is very fun and it attracts me to continue using exergames.	F, 69, Y
	I am feeling that I don't want to lose against my friends. I will make every effort to win.	M, 68, Y
	I felt lonely when I did exercise alone, so I like exergames which allow me to do exercise with people.	F, 68, N
	I enjoyed playing with friends who are the same age as me. It's much more fun to play games or do exercise with	M, 63, Y

	friends than by myself.	
(7) Preference of game art (More details are in table 3)		

^a Participant gender: Male (M), Female(F), ^b had game experience: Yes (Y), No (N)

Additionally, the subthemes of game art preference were generated from the theme of ‘preference of game art’. The qualitative data related to game art was collated and coded into game genres, characters, and scenes (Table 3). In the interview, participants talked about their favorite games ranging from Just Dance, Zumba, Boxing, Kinect Adventures, Kinect Mini Games, Ring Fit Adventure. Adventure games were constantly mentioned as participants’ favorite game (16 out of 22 participants); 11 participants preferred Kinect Adventures, and five participants liked Ring Fit Adventure game. Only 3 participants liked Zumba dance game and 3 liked Boxing game. Thus, most participants were fond of adventure game genre more than sport genre such boxing or dance. Most participants (13 out of 22) preferred game characters of 3D human model with true to scale than others such as cartoon style. On the other hand, some participants (8 out of 22) prefer to see a real man on the screen to lead them for exercise. That is to say, participants preferred the game characters to be real scale of humans or virtual models. Nearly all participants (21 out of 22) mentioned that they enjoyed and immersed in the outdoor or natural scene in the game, while only one participant preferred a static virtual stage.

Table 3. The subthemes generated from the theme of ‘preference of game art’

(7) Preference of game art (8 participants, 36.4%)		
Subtheme	Example	gender ^a, age, game experience ^b
(7.1) Favorite game genres		
	My favorite game is adventure games. It made me focus and immersed myself in the gameplay. The adventure game is very exciting, which could also train my brain and improve my coordination. I don’t usually have the experience in my daily life (XBox).	F, 74, N
	The Ring Fit Adventure provides a more intense and challenging exercise for me. I love to take the challenge.	M, 76, Y
(7.2) Preference of game character		
	I like the game character is made by 3D human-like model with a realistic ratio, such as the character in Ring Fit Adventure. The character looks fit, muscular, and powerful.	F, 75, N
	I prefer a real man in the game, such as the coaches in Zumba game. They are real people, who make it easier to understand and learn their dancing.	F, 69, Y.
(7.3) Preference of game scene		
	I like the game with outdoor natural scenes. I feel like I was doing exercise outdoor rather than in an indoor room.	F, 69, Y.
	I was very excited and fully immersed in the game with a natural scene, such as Xbox Adventure or Ring Fit Adventure.	M, 63, Y

	The natural background made me feel comfortable and I wanted to go forward to see what shows up next. It also keeps me focus on the gameplay (Xbox Adventure).	F, 69, Y
	I prefer static stages in the background, because then I can focus on my game tasks (Boxing).	F, 60, Y

^a Participant gender: Male (M), Female(F), ^b had game experience: Yes (Y), No (N)

Generated themes from the interviews

A total of seven themes generated from the interviews. Among these themes, three (Themes 1, 5, and 7) were initially identified in the current study. The remaining four themes (Themes 2, 3, 4, and 6) align with prior research findings and are further discussed in the "Comparison with Prior Work" section in the Discussion.

Theme 1 Incomprehension of game instructions

Lacking gaming experience in their youth might result in the participants not understanding the game mechanics, the meaning of visual effects or reward icons, health points (HP), or experience points (EP). The instructions in the gameplay were not easy to understand, so most of the participants perceived it negatively. Moreover, even though some participants had game experience, but it does not seem to support their learning in exergames. They still need an appropriate instruction for gameplay learning.

While the game instructions were not helpful for older adults, they needed instructors to explain and teach again to learn how to play. However, even though the participants were taught how to play before the gameplay, they forgot how to play when playing. It was not easy for some senior adults to understand and memorize the given information. Age-related visual and hearing loss might also contribute to increasing the barrier to understand the gameplay. Thus, repetitive and real-time tutorials in games might be helpful to support memory, learning, and thinking. Therefore, simple visual instructions and oral guidance using plain language might support their game learning.

Theme 2 Confusion caused by complicated interface

In general, it can be observed that younger adults tend to find game interfaces more intuitive and user-friendly in comparison to senior adults when it comes to playing digital games. Senior adults often encounter significant challenges when attempting to engage with game interfaces. For instance, take Ring Fit Adventure as an example. This game integrates a diverse range of physical tasks within its exercise regimen. Players are required to perform actions like pressing or dragging the ring with their hands while simultaneously engaging in activities such as jumping, squatting, or running with their feet. The information and tasks presented in the game interface pose a complexity that older adults may find challenging to comprehend. For instance, a participant (Female, age 75, non-experience player) said that 'there is too much information on the screen, I don't know what to look at while playing'. Another participant (Female, age 63, non-experience player) said "the game interface was very complicated and difficult to use". Furthermore, older adults often struggle to grasp the meaning of the icons or virtual objects displayed within the game interface. For instance, they may not be aware that collecting the golden coins in the game can lead to earning additional points. Two participants expressed that "I don't know the meanings of the icons in the game interface."

Theme 3 Frustration caused by fast game speed

The participant expressed frustration and a sense of exclusion when unable to keep up with the game's pace. They desired the ability to control the game's speed, allowing for a more inclusive

gaming experience. The participant (female, age 66, non-experience player) playing Boxing noted that her ability to perform actions effectively was affected by slower response times. She explained, “After seeing the boxing icon showing up from the bottom of the screen, I need to punch at the right tempo. But I was always too late to react. I need some time to think and then do the action”. Another participant (Female, age 82, had game experience) said that “I would give up and feel frustrated when I cannot keep up with the speed of the games”. In addition, participants perceived a decrease in agility compared to their previous exercise experiences, which could be attributed to the natural decline associated with aging. Thus, the inappropriate game speed could result in feeling frustrated and avoid playing exergames from senior adults.

The characteristics of physical fitness are classified into health-related and skill-related components by the American College of Sports Medicine[39]. The skill-related components of physical fitness include agility, coordination, balance, power, reaction time, and speed, which could be adjusted in-game to meet individual conditions. The result showed that the game speed levels should be adjustable according to given skill-related health conditions. Older adults need more time to understand what is going on and how to react accordingly. Therefore, games should provide a range of difficulty levels specifically designed to accommodate different age groups, thereby ensuring an enjoyable gaming experience for senior players.

Theme 4 A sense of control and freedom

Participants in this study shared diverse preferences regarding their choice of gaming controls. Some appreciated the tactile responses provided by using a joystick (3 out of 22 participants, 13.6%) or Ring-Con (7 out of 22 participants, 31.8%), while others found freedom in not having to hold anything when controlling the game such as Kinect motion-sensing interaction (12 out of 22 participants 54.5%). Alongside their appreciation for the sense of freedom, seven participants favored the Ring-Con because it resembled holding a steering wheel, thus enhancing their perception of control.

However, the absence of tactile feedback in certain games left participants uncertain about the accuracy of their movements. For example, one participant described, “Although I feel free when I don’t need to hold anything to control the game. However, I don’t receive tactile sensation feedback to know whether I did the correct movement or not”.

Theme 5 Psychological Perception of Game Technology

Playing exergames was perceived to relate to enjoyment, socializing, achievement, frustration, defeat, and keeping up with trends. Generally, participants enjoyed playing and socializing with people. Also, playing exergames and operating technological devices made them feel trendy, for example, “I feel I am keeping up with trends because I can operate game technology device and share with my grandchildren,” said a 74-year-old female participant. On the other hand, some participants felt frustrated when they could not follow the game speed or got lower scores, due to their longer reaction time and lack of coordination. For example, “I want to have a feeling of achievement, rather than being defeated.” Therefore, the game design should consider their psychological perceptions to meet their emotional needs.

Theme 6 Social interaction

The use of exergames has fostered a sense of connection and engagement, both within the family and among peers. “I enjoyed playing with friends...,” said one participant (Male, age 63, had game experience) and “I like to play with my family, and it is the biggest motivation to play...” said another. Some participants enjoyed the collaboration and competition with team players. For instance, one participant (Female, age 69, had game experience) expressed, “Collaborating with

other players is very fun and it attracts me to continue using exergames". Playing exergames serves as a common interest that allows for enjoyable collaborative experiences, providing shared topics for discussion and enhancing the motivation to continue using exergames.

Theme 7: Preference of game art

The game preference was investigated from game art and game genres. The exergames in the workshop included the latest Nintendo Switch games such as Just Dance, Boxing, Ring Fit Adventure and Xbox Kinect Adventures. Among these games, 16 participants (16 out of 22) were fond of adventure games including Ring Fit Adventure and Xbox Kinect Adventures. Interestingly, the results showed that younger senior adults (5 out of 16 participants, average age 64.7 years) preferred Ring Fit Adventure, which is a resistance exercise and a higher-intensity training game, more than older senior adults (11 out of 16 participants, aged average 72 years). Other participants (6 out of 22) preferred less intensive exercise games such as Boxing and Zumba. Among the six participants, five of them had no previous game experience, and the average age is 73.2 years. Therefore, the younger older adults might prefer a more intensive and resistance exercise, and senior older adults might prefer a gentle exercise with less leg exercise.

For game characters, most of the participants preferred a human or human-like character, because it was easier to understand their movement. The participants also reflected themselves as the avatar if the game character looks like a human. 21 out of 22 participants (95.5%) prefer human or human-alike characters, which 13 out of 21 participants preferred human-like game character and 8 out of 21 participants preferred real human as game characters. One participant did not show her preference. So, among the cute animal characters and human (human-like) characters, older adults preferred human or human-like avatars which allow them to reflect themselves in games easier and observe the exercise movement more clearly.

For game scenes, outdoor nature scenes are the most preferable, such as scenes in the Kinect Adventures and Ring Fit Adventure. 20 out of 22 (90.9%) preferred nature scenes, followed by static scene. The participants felt the nature scenes make them feel comfortable and focusing. Two participants preferred a simple and clean color indoor scenes rather than a sophisticated background, which allowed them to focus on the game mission and not to be distracted by the background.

Therefore, adventure games, human-like characters and nature scenes could create a sense of reality and the participants might be more easily immersed in the gameplay.

Discussion

Most of the participants had no or little experience of playing exergames. However, after playing exergames in the workshop, they found them very interesting and appealing. The results of this study reflected factors of the senior technology acceptance model [26]. Most of them referenced a positive attitude, perceived usefulness, and social relationships regarding using game technology. However, the participants gave negative feedback regarding the perceived ease of use and support of technology use. Lacking experience of playing video games might also resulted in senior adults not having the knowledge and skills needed to adopt game technology.

There are no sufficient supports of technology use such as understandable tutorials or game mechanics to help them. Thus, customized instructions for older adults are strongly needed. Overall, the reasons why participants did not have the intention to play could be because they thought video games were for younger people, not for them. Therefore, exergames should also meet older adults' psychological needs to increase their adoption of game technology.

Principal Results

The result of this study presents older adults' experience, perceptions, and acceptance of game technology toward commercial exergames. Seven themes in total were generated from the interview. Four themes are in line with previous studies, but three themes are identified from this study.

Three distinguished themes generated from this study are incomprehension of game instructions, psychological perception of game technology, and preferences of game art. These generated themes are rarely discussed in prior studies. The participants expressed their psychological perception toward games are fashionable and trendy to play the latest digital games, which were regarded to belong to the youth. They also enjoyed in the gameplay by collaborating and competing with their peers. Among the exergames, the older adults were fond of adventure games much more than other genres. In this study, the adventure games being referred to are Kinect Adventure and Ring-Fit Adventure, both of which focus on players' action tasks. These types of games typically emphasize storytelling and character development, as players assume the role of a principal character who must overcome various challenges and obstacles to reach their objectives. The exciting experience of the outdoor sports motivated them continuing to play, and the virtual environment provided a safe place to do thrilling activities. The game characters and scenes are also critical visual elements to immerse older players in games. Older adults preferred human-like characters which looks healthy, fit, and muscular. The game character with a healthy outlook inspired older players to reflex themselves as energetic people doing exercise in the gameplay. The nature scene of the game also gave the older players feelings of comfortable and relax during the gameplay. Additionally, adjustable intensity and game levels should be carefully designed which could support them to do sufficient amount of physical activities recommended by WHO.

On the contrary, if the older adults cannot understand how to play the game or react in time, they felt defeated and frustrated. They may give up playing straight away. Therefore, game tutorials which are made for older adults to understand easily and game levels which are suitable for their mobile ability are strongly needed.

Comparison with Prior Work

Four themes generated from the qualitative data demonstrated similar issues with previous studies. Firstly, the 'Confusion caused by complicated interfaces' (Theme 2) as well as the 'Frustration caused by fast game speed' (Theme 3) are in line with the results of Aarhus and his colleagues [37] that increasing simultaneous information, speed, colors could be more likely to increase cognitive challenge. Although the study of Aarhus and his colleagues is adopting Nintendo Wii in a physical rehabilitation context. But the issue remains in the current Nintendo Switch. Secondly, the game speed was too fast to follow for most of the participants, which is in line with Brox, Konstantinidis, and Evertsen's study[38]. From the cognitive ability perspective, age-related decreases in working memory cause a reduction in the amount and speed of information processing [35]. Thirdly, the participants in this study highlighted 'A sense of control and freedom' (Theme 4) in gameplay. This result is similar to the study of Thin, Brown, and Meenan [21], who found that the game experience of motion-sensing games is preferable due to its greater freedom and holistic movement experience. Fourthly, 'Social interaction' (Theme 6) is a prominent motivation for senior adults to adopt exergames, which is in line with previous studies [38]. Therefore, social interaction with peers, friends, family, and society formed through playing exergames are appreciated.

The aforementioned themes are also discussed in the previous studies, although most of the tested commercial games in previous studies were Nintendo Wii, Wii fit, Wii balance board, and Wii sports. In comparison with prior studies, the latest Nintendo Switch and Xbox Kinect were adopted in this

study to investigate user experience. However, it is observed that the obstacles such as game speed, interface, and tasks, remains and it shows that the latest games are still not considering the needs of older generation.

The evaluation of this study

According to the criteria for scientific rigor, which are credibility, dependability, confirmability and transferability, in qualitative research proposed by Lincoln and Guba (42), consistent outcomes are expected to be observed when replicating the research process within the same setting. To enhance credibility in this study, the researcher maintained continuous interaction with each participant throughout the data collection process. Furthermore, participants were encouraged to provide examples while discussing their gaming behavior and experiences, with the interviewer posing follow-up questions. This approach facilitated participants' familiarity with both research setting and content, thereby ensuring an accurate interpretation of their original perspectives. Regarding transferability, which pertains to the issue of applicability, the researcher provided detail descriptive data such as participants' demographics, exercise characteristics, technology usage habits, inclusion criteria of recruitment, workshop and interview procedure as well as iterative research process. The information helps the researcher to explain participants' behavior and experience within a gaming context, potentially making them meaningful and transferable to an external observer. To ensure the dependability, which related to consistency, of this study, a detailed analysis process is employed throughout the study(43), thereby establishing the potential for reproducing the study's outcomes across similar participant cohorts and settings. Given the constraints, concerning confirmability, which relates to maintaining neutrality, although the absence of external review is recognized, diligent steps were taken to compensate for this limitation by implementing a rigorous process of self-evaluation and critical reflection on the research process and outcomes. This included a careful examination of the data, consistent cross-referencing with established literature, and self-awareness regarding potential biases.

Strengths and limitation

This study makes a noteworthy contribution by emphasizing the importance of game tutorials, preferences of game art and genre, and the perception of trendiness in game design for older adults. However, the study does have its limitations. Firstly, it's essential to acknowledge that the sample size was restricted to 22 participants, consequently impacting the precision of estimates for main outcomes. Secondly, evaluating the qualitative research's confirmability would ideally involve external researchers. The advantage of having a single researcher code the content is that it ensures consistency and stability in the use of codes; however, confirmation bias can be manifest during various stages of the research process, such as data coding or interpretation(44). As previously stated, a single researcher may hold preconceived ideas or preferences about the outcomes they anticipate or desire, and these biases can inadvertently impact his or her scholarly work. While this study was conducted by a single author, we recognize the inherent limitations associated with solo authorship. The absence of external researchers in this study could limit the diversity of perspectives during data coding and interpretation. This limitation may result in a narrower scope of interpretation and analysis, potentially overlooking valuable insights. By acknowledging our potential biases and preconceptions, we have taken steps to minimize their impact on the study's findings. While collaborative research may not have been feasible in this study, our research process involved continuous cross-referencing with established literature and a sustained awareness of potential biases. We hope that this study will contribute valuable insights to the field of digital exergames for senior adults, despite its single authorship limitations. Additionally, we anticipate that future research will build upon our findings to further enhance our understanding of the elderly's experiences in engaging with exergames.

Conclusions

Exergames could serve as an engaging approach to promote exercise and healthy life among older adults. Most of the prior studies have focused on usability and facilities, but older adults' psychological perception toward exergame experience is highlighted in this study. The findings of this study have some important practical and research implications for adoption of game technology as well as for research with older adults' gameplay experience for future work. First, tailored game tutorials for older adults could be very beneficial for increasing the adoption of exergames to promote physical health. Due to insufficient game experience in their youth and cognitive decline by ageing, understandable and age-friendly tutorials of exergames are strongly needed to equip older adults with affordable information and skills to get into the game scenario and mechanics. Second, the preference of game art and genres is revealed in this study that adventure games are the most favorable game genre and human-alike avatars in the nature scenes are most preferable among older adults. Moreover, evidence from this study and literature showed that the exercise time and intensity of older adults in Taiwan are clearly not sufficient according to the WHO criteria. Thus, the game design is suggested to plan appropriate game time circle and intensity for older adults, which could support them to do moderate or greater intensity gradually to promote their health. In addition to game intensity, the result of this study also shows that the game speed of current off-the-shelf exergames is still not suitable for older adults. Therefore, the intelligent recommended systems of game intensity, speed, or difficulty might be helpful for older adults with various health conditions. Finally, older adults also want to be fashion and keeping up with trend, not to be excluded by the market, so exergame developers may consider including older adults' physical and psychological needs to create age-friendly exergames which are more accessible. Future research could focus on the investigating of age-friendly game tutorials, the developing approachable adventure games, creating adjustable game intensity levels, and designing game artwork for older adults to enhance their exercise for better health.

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Conflicts of Interest

None declared.

Authors' contribution

YHW is the sole author of this manuscript, responsible for conducting the research, analyses, and data verifications. She successfully secured research funding from the Ministry of Science and Technology. Her contributions encompass interpreting the results and granting approval for the latest version of the manuscript.

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Supplementary Files

Figures

Participants played Boxing (left) and Ring Fit Adventure (right).



CONSORT (or other) checklists

A checklist for this study, and is only presented to editors and peer reviewers.

URL: <http://asset.jmir.pub/assets/7a2fb3962175d1770f42ea8c993c1b54.pdf>

