

# Assessing Seniors' User Experience (UX) of Exergames for Balance Training

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## ABSTRACT

Exergames technologies are increasingly used to help people achieve their exercise requirements including balance training. However, little is known about seniors' user experience of exergame technology for balance training and what factors they consider most important for using the exergames. This study aims to evaluate user experience and preferences of exergame technologies to train balance and to identify different factors that affect seniors' intention to use exergames. Fourteen healthy senior citizens played three different stepping exergames in a laboratory setting. Seniors' experience of the exergames and their preference to use exergames was assessed using a semi-structured interview, the system usability scale (SUS), and card ranking. The results of the study showed that in order for seniors to use exergames to train their balance, the exergames should particularly focus on challenging tasks, provide feedback on quality of movement, and provide setup support. Furthermore, healthy seniors did not consider safety to be a concern when playing exergames.

## Author Keywords

Exergames, seniors, older, UX, technology acceptance, balance, exercise and usability.

## ACM Classification Keywords

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## INTRODUCTION

The performance of exercise through video games is known as exergames. The use of exergames is particularly popular among young people and most of the commercial exergames are designed for children and adolescents mainly for the purpose of entertainment. The game industry is growing approx. 10% annually, making it the fastest-growing component of international media. Due to business goals, the game industry is mainly focusing on covering a large population without specific focus on the requirements of senior citizens.

The world's population is "greying", with the proportion of people aged 60 or older projected to double to more than 22% by 2050. With advancing age, several physical functions gradually decline, such as balance, muscle mass and strength, joint range of motion, walking speed, and reaction time. One in three persons over the age of 65 and half of those over the age of 80 fall at least once per year. International guidelines on physical activity in seniors highlight the need for particularly balance and muscle strength training in order to prevent loss of physical function and falls [37]. With a growing senior population, exergame technologies are increasingly used to promote physical activity and engagement in healthy individuals, and in rehabilitation for clinical populations [19, 30]. In order to make the games suitable for keeping older people healthy and independent and prevent functional decline and falls, there is a need for games that work on improving balance. However, the games need to be developed based on the seniors' needs and preferences. For exergames to be persuasive, they should be designed so that seniors not only accept them, but also are willing to use these technologies over time. Thus, development is needed that is based on user-centered design including assessment of user experience (UX) of the exergames. UX is a subjective measure of the quality of a system seen from the users' perspectives [14, 17, 21].

## User Experience (UX) and Usability of Exergames

Usability is a qualitative attribute that indicates how easy devices are to use, and is defined as "the extent to which the

product can be used by the specified users to achieve specified goals with effectiveness, efficiency, and satisfaction in a specified context of use" [14].

UX is a broader concept than usability, and is defined as "a person's perception and responses that result from the use or anticipated use of a product, system or service" [14]. UX is "dynamic, context-dependent and subjective, and related to a broad range of potential benefits users may derive from a product" [17].

In this study, we use UX as an umbrella term to cover the usability, experiences, and preferences of seniors regarding the use of exergames for balance training.

The main objective of this study is to assess seniors' UX of balance training exergames and identify different factors that affect their intention to use exergames. To address this, the seniors played different off-the-shelf balance exergames. Based on their experience, they ranked the games and answered questions on usability of the exergames through the System Usability Scale (SUS) [7].

The study focuses on which factors the seniors themselves considered most important for exergames in general and balance training in particular. We explored different exergames that were either developed for the general public, adapted for seniors, or custom-designed for elderly users.

## BACKGROUND

Virtual technologies and exergames for seniors have been used in healthcare research and clinical purposes since the early 1990s [8, 31]. It is important to design technologies that can help prevent reduce the risk of fall [22]. Exergames have the potential to motivate senior citizens to be physically active. There is a body of research focusing on potential health benefits of using exergames in healthy seniors and for the purpose of rehabilitation of motor impairments [12, 16, 18], rehabilitation after stroke [12, 32], and balance training [15, 26, 29]. There appeared to be cognitive benefits of playing games as well. These benefits include temporary improvements in concentration [10, 32].

What remains unclear is senior users' experience of exergames. User experience studies have mainly focused on single gaming platforms [6] and the effect of exergame technologies [1, 24]. Muscle strength and balance training are the key components of exercise to prevent falling in seniors. If exergames are to be used successfully to improve physical function in senior citizens, they need to be designed specifically for this target group [23].

Several studies have used gaming systems such as Nintendo Wii, Microsoft Kinect, and Xbox to enhance physical activity in senior citizens [8, 11, 31]. These studies concluded that seniors found these games motivating to be physically active and that the games improved social contact between participants [36].

In another recent study [28], we have described in detail that we lack knowledge about the characteristics of the movements elicited by exergames and thereby about their potential to train functions which are important for fall risk reduction. In order for exergames to be usable for elderly people, the game should elicit different movement characteristics such as weight shift, variation in step length, step speed and movement direction, and visual independency [28].

Studies have shown that commercially available games may not be suitable for use in rehabilitation or for senior users because these games are not developed according to the needs of seniors [13, 38]. Therefore, we chose three stepping exergames that were designed and developed with different purposes in mind. These games included a modified version of the open-source game DanceDanceRevolution (DDR) [26], The Mole from SilverFit [27], and LightRace in YourShape: Fitness Evolved [13, 34, 38].

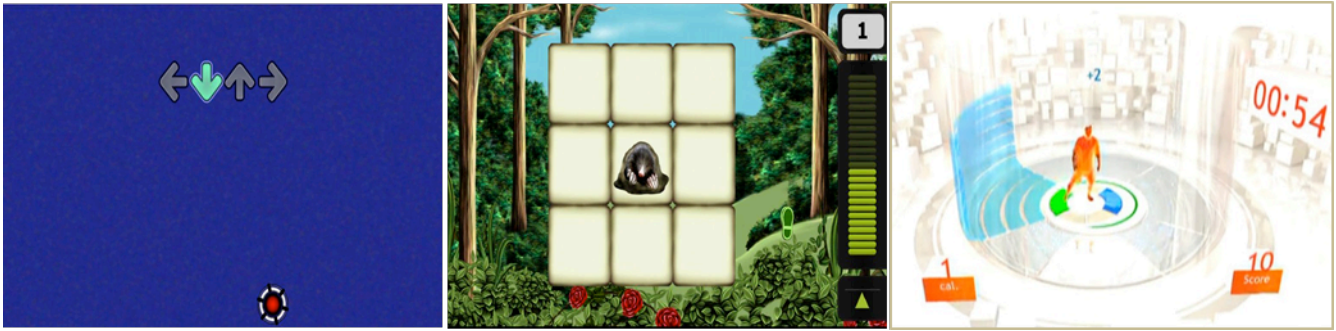
## METHOD

In this section, we first describe the assessed exergame technologies and their functionalities. Subsequently, the section explains the study setup and how seniors' experiences and perceptions of exergames were assessed. Then, the procedure and participant details are outlined.

### Assessed Exergame

The first exergame, DanceDanceRevolution (DDR), is an interactive game produced by Konami Corporation that can be played on several consoles, such as Sony PlayStation, Microsoft Xbox, Nintendo Wii, as well as on a PC. DDR is a general-purpose exercise game that was originally released in Japan as an arcade game. The game is also used in tournaments where users compete for scores and perfection by moving in different ways to achieve better scores. Many schools also use DDR as a physical education activity in the gym [33]. The modified DDR is better suited for seniors because of its simplified interface and reduced stimulus speed and step rate (see Figure 1, left panel).

*Functionality:* The player stands in the center of a 3x3 pressure-sensitive panel (step pad), and controls the game by stepping on four arrows; left, right, forwards and backwards. Music is played during the game, but not synchronized with the game. On a screen in front of the player, arrows drift from the bottom up to one of four target arrows on top of the screen. Participants have to time each step and hit the corresponding arrow on the pressure sensitive mat when the moving arrows overlap the stationary arrow on the screen. In addition, pictured bombs can drift from bottom to top, in which case the player needs to suppress a stepping response. The game has three levels of difficulty, Easy, Medium, and Hard. For this study, the participants played one song on the easy level, with an overall number of 72 steps and 8 bombs occurring during the duration of the game.



**Figure 1: The interfaces of DanceDanceRevolution: Modified version (left panel), SilverFit's the Mole (middle panel), and YourShape LightRace (right panel).**

The second exergame, The Mole, is developed by SilverFit [27]. The game is a virtual rehabilitation system or a computer-aided therapy system that provides patients and seniors with virtual environments, such as a garden, where they can perform functional tasks [25]. According to the website of the development company, "The SilverFit is a system for virtual rehabilitation. It has been developed for people who have to exercise regularly as part of a rehabilitation program. The system is designed specifically for elderly users" [27].

*Functionality:* The SilverFit system uses motion-sensing technology time-of-flight (ToF) to capture movements of the player's feet. A 3x3 grid pattern is shown on the screen. All the foot movements of the player in a 3x3meter area in front of the camera are registered. In the game The Mole, a mole appears in one of the grids and the player has to step on it to make it disappear. There are two levels of difficulty, Easy and Precision Control. In the latter, a cognitive load is added by a mouse showing up on the screen that should be stepped on before disappearing, and two ladybugs that should be avoided (see Figure 1, middle panel). The animals appear randomly on the screen, and the player receives points for stepping on a mole or mouse, and a penalty for stepping on a ladybug.

The third game, LightRace from YourShape: Fitness Evolved, developed for PC and XBOX, is a fitness game that targets muscle strength, balance, and cardiovascular fitness [34].

*Functionality:* The Kinect sensor device consists of an infrared depth-sensing camera, a RGB camera, and an infrared laser projector that estimates the 3D geometry of the acquired scene at 30 frames per second. The Kinect recognizes full-body motion in 3D, and the player controls the game through his/her virtual character on the screen. For this study, the game LightRace was chosen, in which the player has to step on the area that lights up around the player on the screen (see Figure 1, right panel). The game has three difficulty levels, Easy, Medium, and Hard. In the current study, participants played one minute at the easy level. At this level, four different areas could light up, two areas in the front, one to the left, and one to the right (see Figure 1, right panel). Stepping on the correct area turns it

green, an affirmative sound is presented, and the score increases. When stepping on the wrong area, the area turns red without further penalty. The game has accompanying background music and a voice-over provides positive and negative feedback on how the player is performing.

### **Assessing User Experience of Exergames**

There is no general framework for assessing the user's experience and preferences of exergames. User experience of playing games has been assessed by a variety of concepts, including immersion, fun, presence, involvement, engagement and flow [5]. Different methods have been chosen, depending on the game development phase spanning from the conception phase to production phase.

In the current study, we assessed exergames during the implementation and testing phase. We are interested in knowing which factors seniors consider as most important for using exergames to train balance in order to use it at home at a regular basis. The assessment of the exergames will help us to decide which factors of exergames seniors consider to be important for continuing balance training at home. According to Bernhaupt [4], during the implementation and testing phase the user experience of games can be assessed through play testing, semi-structured interviews, and questionnaires focusing on the user's attitude and experiences.

In line with Bernhaupt [4], this study assesses UX of exergames through seniors' preference of exergame use, usability of exergames, and their experiences of exergame play. The preference of exergame use was assessed through card-ranking, usability of exergame was assessed through system usability scale (SUS), and users' experiences were gathered through semi-structured interviews after playing the three exergames.

The system usability scale (SUS) provides a global subjective view of the usability of a product or a system [7]. SUS has showed to be a valuable evaluation tool, being robust and reliable [7]. With regard to exergames, SUS provides information on whether seniors are confident playing the games, whether they will want to use the exergames frequently, and whether the exergames are easy to use for balance training and physical activity.

In order to be useful for assessment of exergames in our study, the SUS questions were adapted for this study. Following are the questions that were used in the study.

1. I think that I would like to use this exercise-game frequently
2. I found the exercise-game unnecessarily complex
3. I thought the exercise-game was easy to use
4. I think that I would need the support of a technical person to be able to use this exercise-game
5. I found that the various functions in this exercise-game were well integrated
6. I thought there was too much inconsistency in this exercise-game
7. I would imagine that most people would learn to use this system very quickly
8. I think the exercise-game was very difficult to use
9. I felt very confident using the exercise-game
10. I need to learn a lot before I can get started to use this game on my own.

Card ranking can be used to assess the users' perceptions and ranking of the technologies and which technology they would be most likely to use in the future. More specifically, the card sort method can be used to understand the relationship between items, to group the items into categories, or to understand the participants' perception of organizing the items. In card sorting, the test leader selects a set of items that are placed on separate cards. These items can be statements, words, pictures, instructions, tasks etc. The participants are asked to sort the cards according to the test leader's instructions. In this study, the test leader created three different cards from cardboard that contained a picture each of one of the games. The participant was asked to order the cards according to their preference of the games. The objective was to understand which exergame seniors liked the most and which exergame they liked the least.

#### Model for Technology Acceptance

There are a number of models that have been developed to describe barriers and intentions of users in using technology and that have been used to assess technology acceptance by the target population.

The Unified Theory of Acceptance and Use of Technology (UTAUT) is a unified model for technology acceptance that integrates eight previously developed models into one comprehensive model [9, 35].

Researchers use the constructs of the UTAUT to assess the degree of technology acceptance by a target population. Table 1 shows the main constructs of the model.

A semi-structure interview was conducted with each participant at the end of the test session in order to obtain information about the seniors' understanding and views about the exergames. The constructs of UTAUT were used as an inspiration for interview questions.

Construct	Definition
Performance Expectancy	Degree that the user believes that using the system can improve performance
Effort Expectancy	The easiness that an individual thinks of when using the system
Social Influence	Degree that an individual senses that the person who is important to him thinks that he should use the new system
Facilitating Conditions	Degree of support that an individual feels from the organizational and technical relevant equipment towards system use

**Table 1: Constructs of the Unified Theory of Acceptance and Use of Technology model.**

#### Participants

Participants were recruited from several exercise classes for seniors in Trondheim, Norway, where the study was conducted. In order to be included, participants had to be 65 years or older, and have no severe health problems or cognitive disability. Eighteen seniors were recruited for the study. However, three of the seniors did not meet due to other commitments, and one did not meet the minimum age requirement for participation. Thus, a total of 14 healthy seniors (9 female, 5 male) were included in the study. The participants had an average age of  $73 \pm 5.7$  years (range from 65 to 85 years). All participants had a mobile phone which they used several times a day and were users of internet at least once a day.

#### Procedure

The study was conducted at the university in a usability lab that conducts research in health informatics. The lab consists of three rooms plus an observation room. The usability lab is equipped with three ceiling-mounted cameras, which are monitored and controlled from the observation room. The main test area was set up with gaming equipment and offered enough space for participants to engage with the games.

At the start of a test session, the test leader introduced the participant to two test facilitators who had different roles during the usability testing. One of the test facilitators was videotaping the sessions from the observation room. The other test facilitator stood behind the seniors for safety in case of balance loss when playing exergames. Participants were asked to fill out a questionnaire on general background information, use of technological experience, and fitness level. The test leader explained the on-screen game elements and demonstrated how to play the exergame before the start of each game. The order of the exergames was counter-balanced across participants.



**Figure 2: Examples of seniors playing DDR (left panel), SilverFit's the Mole (middle panel) and YourShape LightRace (right panel).**

The participants played each of the three exergames once. They were provided with assistance when required during gameplay. The participants played DDR for approximately three minutes, TheMole for two minutes and LightRace for one minute.

Figure 2 shows participants playing DanceDanceRevolution (left panel), The Mole (middle panel), and LightRace (right panel). After playing each game, participants filled out the SUS questionnaire for that particular game. This process was repeated three times. After having played all three games, the test leader conducted a semi-structured interview based on the constructs of the technology acceptance model to assess users' acceptance of the game technology. Finally, the participants were shown three cards, each card representing an exergame, and they were asked to rank them in order of positive experience and liking of the game.

#### Data analysis

Data was analyzed by qualitative and quantitative methods.

Exergame usability was quantified from users' scores on the SUS. For SUS, scores in the range of 0 to 100 were computed by combining a user's ratings. Bangor et al. [2] established a baseline of 70 for an acceptable SUS score of a product. A SUS score below 70 indicates that the system has one or more usability issues and should be further improved, while very good systems will score in the high 80s. Mean and standard deviation for SUS was calculated for each of the three games.

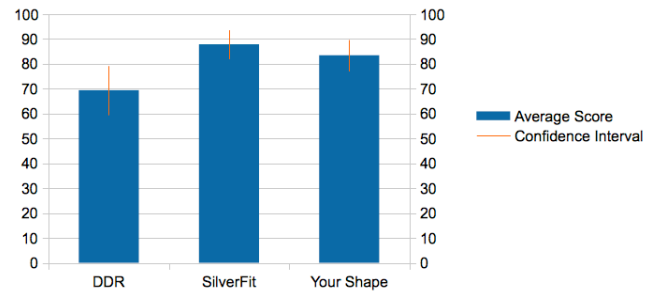
Card ranking of the three games used three preference levels ranging from least (score of 1) to most (score of 3) preferred. A Friedman test was performed on the results of the ranking to quantify which exergame the seniors ranked the highest.

All statements and exclamations during the semi-structured interview were transcribed in Norwegian. To explore what factors seniors considered important, constructs were generated through coding in ATLAS.ti [20]. In addition to the emergent constructs, the users' statements were coded through components of UTAUT. Positive experience and issues were indicated with a (+), and negative experiences and issues were indicated with a (-) sign.

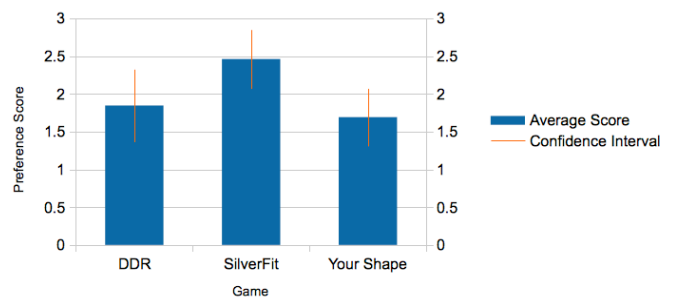
## RESULTS

### Exergames Usability

The usability of all three exergames was assessed through the system usability scale (SUS). Figure 3 shows the mean SUS scores with 95 % confidence intervals (CI) for each exergame. SilverFit demonstrated the highest usability score among the three selected exergames:  $87.0 \pm 11.1$  (Mean $\pm$ SD), 95% CI [81.15, 92.77]. The modified DDR demonstrated the lowest usability:  $69.6 \pm 18.9$  (Mean $\pm$ SD), 95% CI [59.74, 79.54]. DDR was also the exergame with the largest CI in usability score across the seniors. The system usability score for YourShape was  $83.75 \pm 13.1$  (Mean $\pm$ SD), 95% CI [76.89, 90.61]. A one-way ANOVA gave a significant result ( $p=0.007$ ). Post hoc comparisons using a Tukey test indicate a significant difference between DDR and SilverFit, and between DDR and Your Shape, but not between SilverFit and Your Shape.



**Figure 3: Average SUS score of the three exergames and corresponding 95% Confidence Intervals.**



**Figure 4: Average card ranking score with corresponding 95% Confidence Intervals.**

### Preference to Use

Figure 4 presents results from the card ranking. Overall, participants preferred the SilverFit over the two other games, but the difference was not significant ( $p=0.26$ ).

### Important factors of Exergames

Below we have summarized issues that were raised by the seniors in the interview after playing the games. User experiences based on the semi-structured interview were linked to the components of UTAUT and are presented as + (positive)  $\pm$  (neutral) or - (negative) in Table 2.

TAM Constructs	Related issues
Performance Expectancy	+ improve balance and keep in shape + cognitive challenge $\pm$ music
Effort Expectancy	$\pm$ understanding the concept of games - perform correct movements
Social Influence	+ No social influence
Facilitating Conditions	- Small space
Emerged Constructs	Related issues
Social experience	+ Playing with grandchildren + Playing with seniors $\pm$ Playing alone
Safety	+ Not concerned (Healthy seniors)
Setup	- Need support to setup exergame system
Progression	+ Progression through game difficulty
Localization	- Game content available in foreign language only (English)

**Table 2: User experiences based on constructs of technology acceptance model and emerged constructs in the interviews.**

#### TAM Constructs

*Performance expectancy:* One of the important aspects for users to use a system is performance expectancy. The performance expectancy in this case is defined by whether the users think that performance in the game would give them expected results. All participants said that they saw the potential benefits of using these games for exercise. Single participants expressed this as: “It is a good way for keeping myself in shape [P3]. I think it is possible to train a bit of balance and control of movement with such games” [P6]. “I think I could use these games to improve my balance as well as my ability to react” [P10]. “I think it would be useful, especially at our age; we need to train our concentration and exercise reacting in a decent time frame. And if you use these games consistently, you could

probably delay the slowing down of the mind for a while” [P13].

Participants also stated that the unsynchronized music in the DDR affected their movement quality adversely while playing the exergame.

*Effort expectancy:* Effort expectancy is concerned with the degree of ease associated with the use of the system. In the case of exergames, effort expectancy is related to how much effort is required to play the exergames. The assessment of the exergames indicated that seniors easily understood the concepts of exergames after the short demonstration by the test leader. All seniors managed to complete all three exergames, although some participants experienced more difficulty than others while playing. However, many of the seniors did not know how to perform the required stepping movements correctly, and they wanted to receive feedback on how they performed the movements. For example, in relation to the DDR, many of the seniors had difficulty with stepping on the correct square at the correct time: “It was a bit tricky to step exactly on the area of the arrows. In the other game (referring to YourShape), the sensitive area was much larger so it was easier to hit the targets” [P13].

Participants also wanted clearer feedback when they missed the target due to incorrect movement or slow movement: “I wonder, why did I miss it? Was I too slow, or was it that I miss-stepped on the squares?” [P5].

Participants expressed that instructions and feedback were not provided in their own language: “Yes it looked fine, however what is required from exergames is that the exergame should show the Norwegian subtitles. If you are presenting this to seniors in Norway, I think you should ensure that it is in Norwegian” [P6].

*Social influence:* Social influence is concerned with how the people around the participants could influence their potential use of exergames. The general opinion from the participants was that they would not feel uncomfortable to tell the people in their life about playing exergames: “Everything I do to move my body I’m not afraid to share” [P8].

The participants expressed that the way the exergames could promote social interaction had much to say: “I could play this with the wife” [P13].

Another participant stated that: “It would be fun to play with my grandchildren” [P12]. “If you could compete with a grandchild for example. That would be fun. We could see who could step on the most mice. Look what Grandma can do” [P1].

*Facilitating Conditions:* Facilitating conditions is concerned with the degree that seniors believe that they have the support and facilities to use the exergame system. Facilitating conditions tend to negatively contribute to the user experience of the seniors because many of the seniors



are living in small apartments and nursing homes cramped with furniture, which leaves little room for the needed equipment and playing space.

#### ***Emerged Constructs***

*Social Experience:* Social experience in an exergame context is related to social interaction while plying the game. Generally, social experience was positively related to game experience of seniors. Seniors expressed that they wanted to play exergames with their grandchildren and fellow seniors. Seniors were of the opinion that the games would become more useful if they supported the social experience and allowed them to play with other peers. However, the oldest participant of the study was not interested in social experience while exergaming. She stated that it was more important for her to do the exercise correctly.

*Safety:* Safety is related to seniors' perceived risk of falling or injury when playing exergames. Since the participants of the study were relatively healthy seniors, they did not feel any risk of falling or injury when playing the games.

*Setup:* Game setup is concerned with the process of setting up the game to be used. Seniors considered the exergames technologies to be quite advanced and were concerned whether they could setup and start the game on their own.

*Progression:* The progression in the exergame is concerned with the advancement in the game and movements while exergaming. The participants regarded progression in the game as an important factor for gameplay in seniors. They expressed that progression in the games can be achieved by gradually increasing the game difficulty. The use of music was another way to make progression. It was mentioned that slow music can be used at the start of the exergame and faster music after some time so that seniors can perform more extensive movements. Finally, users also expressed that game score was an important motivator for achieving progression in the game.

*Localization:* Generally, the exergames are designed to cover larger users groups; therefore the interface and the information in exergames were displayed in the English language. The participants expressed that exergames' utility can be increased by providing the support of local text or subtitles in the local language. None of the participants were native English speakers, although all of them had certain knowledge about the English language.

#### **DISCUSSION**

The purpose of this study was to assess user experience of exergame technology for balance training, and what factors seniors consider as most important for using exergames to train balance. Results from interviews indicate that in addition to technology acceptance seniors considered setup, progression, and localization for exercising as important.

We will discuss these issues in accordance with TAM and the issues raised by the seniors in the interview.

*Performance expectancy:* In term of performance of the games, the seniors were of the opinion that use of exergames could improve their movement, which would result in better balance and cognitive abilities. As indicated in earlier research, balance exercises can indeed improve balance of healthy elderly people [26] and of elderly people with balance deficits [1], and improve cognitive ability such as concentration [10, 32]. In line with feedback of the elderly people, the choice of music in the exergame could hinder the concentration if the music was not synchronized with the game elements appearing on the screen. Therefore the music needs to be synchronized with the elements of the game.

*Effort expectancy:* The game concept SilverFit did not require much effort regarding the game concept, and it was easier for elderly people to follow. The other two game concepts, DDR and YourShape, were relatively difficult for elderly people. Nawaz et al. [23] have indicated that elderly people like game concepts such as picking apple and walking in nature because they can relate these kinds of concepts to their daily life activities. Seniors also demand that exercise effort through video games yields the right results in term of training different parts of body. The design of exergames can offer options to train different muscles before the start of the exercise [23].

*Social influence:* Seniors were of the view that they would not be embarrassed in using game technology for physical activity. However, the study was conducted in Norway that has an individualistic society where an individual is expected to stand for him or herself and is less concerned of what others would say [23]. Social influence of using game technology for exercise might vary depending on the geographical location of seniors.

*Facilitating Conditions:* Many of the seniors were living in smaller places. Therefore, video game equipment needed for the exercise could be set up in a permanent area to facilitate better user experience and avoid that seniors have to move around furniture or clear the living room each time they want to play.

*Safety in exergames:* We learned from the study that relatively healthy seniors are not concerned about their safety when playing exergame. Safety is a crucial and decisive factor for whether the exercise is suitable to be played by seniors or not. Senior's feedback regarding safety is in line with the results of a recent study with thirty seniors who played the balance exergame DDR for 6 weeks without experiencing adverse events [26].

*Support for setting up Exergaming systems:* Seniors use technologies with caution. An easy access set-up of the exergaming system is an important factor that is likely to influence regular use of the game. Therefore, there is a need of support for setting up exergame systems in the person's home environment.

*Progression:* Elderly people regarded progression as an important factor. The exergames need to provide progression in the game by rewarding correct movements and gradually increasing difficulty. Progress also entailed clear feedback of correct movements.

*Localize the game contents:* We learned from the present study that for seniors, the exergame content should be localized for better UX. The information should be presented in the local language of the users. The research within usability has emphasized that localization of content reflects cultural sensitivity and understanding of the targeted audience [3, 21]. Providing the contents in the local language helps seniors to understand the game concepts more easily.

#### **Usability and seniors' preference for exergames**

The results from the card ranking as well as the SUS questionnaires filled out for each of the three selected games show that seniors preferred the SilverFit game over the two other exergames Dance Revolution and YourShape. A total SUS score of 87 points indicates a high score, based on recommendations from Bangor et al. [33] who provided a baseline score of 70 points as an acceptable score on the basis of system usability scale.

#### **Validity of study**

There are a number of potential threats to validity of the current study. The number of participants (N=14) was sufficient to give statistically significant results ( $p < 0.05$ ) for the SUS questionnaire (ANOVA  $p=0.007$ ), but not for the card ranking (Friedman  $p=0.26$ ). The ranking data should consequently only be taken as indications of preference, although the results are supported by the qualitative data from the post-test interviews.

The participants were above average healthy, both physically and mentally, for this age group. They were recruited from exercise classes for seniors, and one can assume that their motivation for doing physical exercises was above average compared to the population of Norwegian seniors as a whole. This, in addition to their fairly high familiarity with digital technology, might have affected their assessment of the games.

Only three exergames were compared. A higher number of games might have given more insights into the factors that affect user acceptance, but the richness of the verbal data from the tests indicates that three games was sufficient to get a good indication of what issues the participants find most important for this class of games.

In retrospect we see that neither SUS nor UTAUT have explicit constructs for measuring the participants' intrinsic motivation, which is one of the most important success factors for games. This does not invalidate the SUS or UTAUT results of the study, but additional instruments could have been added to get more insight on aspects of fun and "flow" in the games.

## **CONCLUSION**

The current study illustrates the importance of assessing UX of seniors when exergaming for balance training. Healthy seniors liked SilverFit that was specifically developed for seniors the most. Thereby, the study indicates the need for designing exergames that are purpose-designed for seniors. The feedback of seniors indicates they think exergaming could improve their balance and keep them in shape. However, exergames need to provide feedback regarding the correct movements in a game. The study further indicates that in order for exergames to be positively experienced by seniors, the games need to present the content in the local language. In relation to future concepts for exergames for balance training, the study indicates the need to design exergames that provide feedback on correct movements for balance training.

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