Considerations for Player Enjoyment and Exertion in Casual Exergames

Erik Berglund, Izabella Jedel, Helena Orädd, and Aseel Berglund
Linköping University, Department of Computer and Information Science
{erik.berglund, izabella.jedel, helena.oradd, aseel.berglund}@liu.se

Abstract

One approach to reduce sedentary behavior is through casual exergames, exergames with simple game mechanics played during short time increments. Casual exergames have shown success in producing enjoyable experiences and sufficient levels of exertion. Yet, previous research has neglected what to consider in order to design enjoyable and exerting experiences in casual exergames. The present work explores this aspect through an exploratory mixed methods research design, comparing the perceived exertion and enjoyment of four different casual exergames. In relation to traditional exergame guidelines we recommend that casual exergames focus on allowing for high ambiguity of movements, balance the cognitive complexity of the game, and direct players' attention from the body by utilizing fast game pace.

Keywords: Exergames, Casual exergames, Exertion, Enjoyment, Design considerations.

1. Introduction

Prolonged periods of sitting is associated with a broad range of mortality outcomes (Chau et al., 2013; Ekelund et al., 2016). Including moderate levels of physical activity can positively impact peoples' overall health and quality of life (Lachman et al., 2018). One approach to motivate physical activity is through exergames, computer games in which people interact through physical exertion (Mueller et al., 2008). Exergames can produce positive experiences (Sinclair et al., 2007), while encouraging sufficient levels of exercise associated with health improvements (Dutta & Pereira, 2015). A specific type of exergame targeted at short durations of physical activity to reduce sedentary behavior is casual exergames (Gao et al., 2014; Yoo et al., 2020).

From a health-related standpoint both the hedonic, psychological attractiveness of exergames, and the utilitarian, physiological effectiveness of exergames, need to be considered (Sinclair et al., 2007, 2009). I.e., the exergame needs to be fun to play (hedonic) while at the same time eliciting the health related (utilitarian) benefits associated with movements. In relation to promoting the hedonic nature of exergames, Isbister & Muller (2015) developed ten exergame guidelines based on their own experience and discussions with experts (Table 1). While the guidelines offer direction toward the design of exergames in general, they, along with other exergame guidelines targeted at specific types of exergames, have been criticized for not considering the utilitarian dimension of exergames (Subramanian et al., 2020). Since hedonic and utilitarian design guidelines might be contradictory (Subramanian et al., 2020), existing guidelines might not offer the full picture of designing successful exergames. Furthermore, while the guidelines have been developed to increase the hedonic experience of exergames in general, less in known about how and if the guidelines apply to casual exergames.

Casual exergames are based on the principles of casual games (Gao & Mandryk, 2011): easily learned games, with simple controls, played during relatively short periods, with non-punishing game play, that speak to player's desire for fun, and are inclusive (*Casual Game White Papers IGDA*, 2008), and differ from exergames in the sense that they are: easy to learn, easy to access, and motivate people to be physical active at moderate intensity for short periods of time (Gao & Mandryk, 2011). The casual nature of casual exergames, might imply that previous suggested guidelines (Isbister & Mueller, 2015; Subramanian et al., 2020) matter to a greater or lesser extent in casual exergames. For example, to allow for easily learned games (*Casual Game White Papers IGDA*, 2008) reducing the cognitive complexity of movements might be of additional importance. Other guidelines might also contribute to too high complexity in relation to the simple game play that casual exergames intend to elicit (*Casual Game White Papers IGDA*, 2008) such as mapping movements in

URI: https://hdl.handle.net/10125/106541
978-0-9981331-7-1
(CC BY-NC-ND 4.0)

Table 1: Exergame Guidelines developed by (Isbister & Muller, 2015)

Guideline cluster	Guidelines
Movement requires special feedback	1a. Embrace ambiguity of movements rather than require precise control. 1b. Celebrate movement articulation by providing feedback on how and when movements occur. 1c. Consider cognitive load of movements by not requiring complex movements when the game challenge is high and give players time to learn new movements. 1d. Focus on the body by using less screen-based feedback or divert attention from the body to reduce self-consciousness.
Movement leads to bodily challenge	2a: Use fatigue intentionally by making it part of the game challenge or keeping game cycles short and movements varied to reduce risk of unintended negative fatigue. 2b: Exploit the risk that comes from physical movement which can contribute to a sense of thrill. 2c: Map movements imaginatively to make the avatar's movements look more exiting and/or realistic than the player's movements might be.
Movement emphasizes certain kinds of fun	3a: Highlight rhythm in movements by including movements that become easier when keeping a beat. 3b: Support self-expression by allowing different kinds of movements or performance from movements that do not directly affect the goal of the game. 3c: Facilitate social fun through designing for multiplayer or an audience

imaginative ways or using fatigue intentionally (Isbister & Mueller, 2015).

Despite the unique nature of casual exergames, limited research has been conducted with the aim of providing design guidelines and recommendations targeted at casual exergames specifically. Instead, previous research in the context of casual exergames focus on *if* and not *how* casual exergames produce sufficient levels of exertion and enjoyment. One potential reason could be due to the fact that casual exergame studies focus on the design and development of individual casual exergame. In the context of computer based casual exergames several studies have investigated the casual exergame GrabApple (Gao et al., 2014; Gao & Mandryk, 2011; Gao & Mandryk, 2012). The game was designed with casual game guidelines (*Casual Game White Papers IGDA*, 2008**)**, however, no other conclusions are drawn from the studies about how to increase the hedonic and utilitarian, i.e., enjoyment and exertion, aspect of the casual exergame. Another study investigated two different casual exergames for children using wheelchairs (Hicks & Gerling, 2015). However, the games only evaluated children's' experience with the games without addressing the increase of enjoyment or exertion specifically. Two other studies have investigated specific design considerations for casual exergames: one compared whole body interaction and upper body interaction in the same casual exergame and found that using only upper body movements could be as beneficial as using full body movements (A. Berglund, I. Jedel, H. Orädd, & E. Berglund, 2023) while the other compared the same casual exergame with and without assigned goals, and found that assigned goals lead to higher exertion, enjoyment, and performance (E. Berglund et al., 2023).

Based on the need to consider hedonic and utilitarian dimensions in exergames and the lack of specific guidelines targeted at casual exergames, the aim of the present study was to explore which aspects could affect exertion and enjoyment in casual exergames by comparing the level of perceived exertion and enjoyment between different casual exergame. The following research question was explored: *What should be considered in the design of casual exergames to produce perceived exertion and enjoyment?*

2. Method

A comparative exploratory study was conducted with a mixed method design, comparing four different casual exergames originally developed to be included in a gamified micro-break application (A. Berglund, I. Jedel, H. Orädd, J. Fallström, et al., 2023). The exergames were chosen as they provide a variation of adherence to the exergame guidelines suggested by Isbister & Muller (2015).

2.1. Casual exergame designs

All four casual exergames adhered to the principles of casual games (*Casual Game White Papers IGDA*, 2008) by employing simple game mechanics and movements that are easy to learn, have a short (2-minute) game play duration, non-punishing game play (e.g., the player can never lose the game), inclusivity (e.g., easy game mechanics and simple game themes) and speaking to players' desire for fun (e.g., including scoring or level systems).

The first casual exergame *Platform* (Figure 1.), is a casual platformer exergame. Platform games are a subgroups of action games where the player moves across platforms in a vertical 2D space while avoiding obstacles and fighting enemies (Adams, 2014). Platform utilizes three different movements: squatting

to jump, extending the arm to the side to move horizontally, and touching the nose to stop. In the game the avatar runs forward and jumps on platform to get as far as possible in the game. If the player manages to get far enough, he or she reaches a new level. On later levels the player also encounters enemies. The player has three lives in the beginning of the game, and if a player collides with an enemy the player loses a life. If all three lives are lost, the player starts over from the closest checkpoint reached. The player can also collect coins across the map, and the number of collected coins together with the number of lives remaining is visible in the top right of the screen.

The second casual exergame *2022* (Figure 2.), is a casual shooter exergame, utilizing two different movements: raising both arms to shoot and moving sideways to steer to the side. Shooter games are games where the player is approached by enemies that can kill the player and has to shoot down as many enemies as possible (Adams, 2014). In 2022 the player gets points from shooting enemy planes and collecting coins, which is combined into the total score visible on the top right of the screen. If the player gets hit or collides with a plane the player starts over at the beginning of the map. If the player reaches the 2-minutes without dying, they achieved 10 extra points.

The third casual exergame *Crossing* (Figure 3.), is a casual action exergame. Action games are games involving physical challenges such as need for quick reaction times and fast actions (Adams, 2014). Crossing utilizes two different movement: raising both arms to jump forwards and raising one arm to jump to the side. In the game the avatar representing the player stands still until the player raises their arm(s) to make the avatar move. The player needs to cross roads with vehicles and rivers with floating logs. For each jump forward the player gets one point, combined into the total score visible on the top right of the screen. If the player jumps into the water, collides with a vehicle, or does not jump forward before the screen reaches the avatar, the game starts over at the beginning of the map. The current score is kept after dying, but the player must wait five seconds to begin moving again.

The fourth casual exergame *Swim* (Figure 4.) is a casual exploration exergame. We define exploration games in this context as games that allow the player to explore the game world at their own pace without external pressure. Swim utilizes three different movements: a swim stroke with both arms to swim a long distance forward, a swim stroke with one arm to swim a short distance forward, and moving sideways to rotate the position of the avatar. The avatar representing the player swims around in an aquarium to gather baby fish towards corals and collect coins. If all the baby fishes are taken to the corals the player reaches the next level. The player can also see the total coins collected in the top right of the screen. The player has no possibility of dying in the game. At later levels, enemies can scare away baby fish from the player so the player must collect them again.

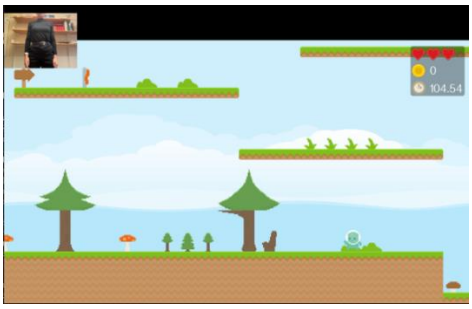

Figure 1. Platform interface

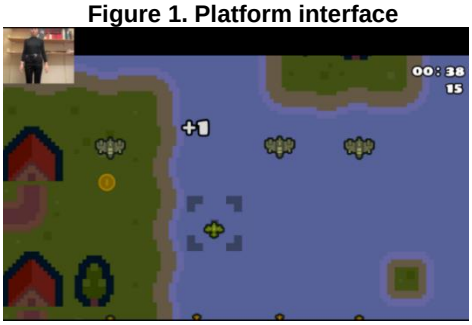

Figure 2. 2022 interface

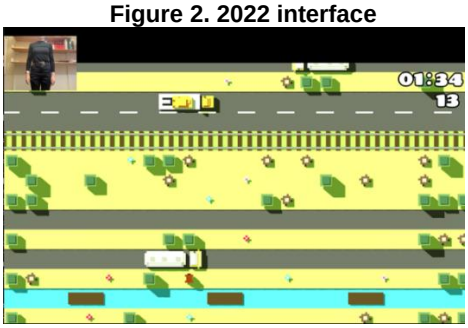

Figure 3. Crossing interface

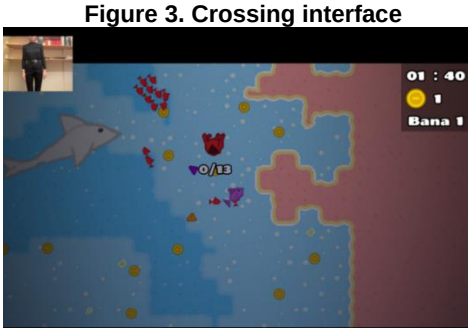

Figure 4. Swim interface

2.2. Guidelines and game differences

In the context of understanding *what should be considered in the design of casual exergames to produce perceived exertion and enjoyment*, the four

different casual exergames were chosen as they adhered to previous exergame guidelines (Isbister & Muller, 2015) in various ways. Three of the guidelines were not addressed in any of the casual exergames. Exploit risk was excluded due to ethical reasons of not harming study participants and due to casual exergames being played in everyday environments that risk causing harm to other people. Support self-expression was excluded as introduction of additional movements that do not relate to the goal of the game did not fit with the very short gameplay time. Celebrate movement articulation was not implemented for similar reasons as the focus of casual games is to perform many actions quick rather than encouraging articulation. Finally, facilitate social fun was excluded as the application the casual exergames were designed for had its own implementation for social interactions (A. Berglund, I. Jedel, H. Orädd, J. Fallström, et al., 2023).

In terms of embracing ambiguity, simple rules based on states were used in all four casual exergames to detect movements, meaning that movement could vary and still be registered. Crossing and 2022 had very simple rules while more precise movements were required for Platform to detect the movements correctly, and even higher precision was required for Swim. In terms of cognitive complexity, all exergames were controlled with simple movements and the game mechanics were simple. For Platform and Swim three movements were used that also required multiple parts of the body, introducing higher cognitive complexity compared to Crossing and 2022, that only used two movements. The cognitive complexity was also higher in Swim since the movements utilized required higher precision and were thus more difficult to master, and in Platform, as the graphical elements varied to a greater extent compared to the other exergames. In terms of focusing on the body, all exergames included a time pressured, high paced game play that forced players to focus on the movements and keep them from becoming self-conscious. The pace was the highest for Crossing and 2022 due to obstacles that could kill players if they stood still for too long, slightly lower for Platform in which the player needed to jump to progress through the game but could also stand still without being killed, and the lowest for Swim, in which it was possible to stand still without being killed and in which players could gain points without movements. Reward systems were also implemented in the games as a way to distract players from feeling tired by bringing down the focus on the body. In terms of intend fatigue, all four exergames utilized scoring systems that encouraged rapid movements that resulted in fatigue. As with to the pace of the exergame, this was the highest for Crossing and 2022, followed by Platform and finally Swim. In terms of mapping movements imaginatively, the players movements were related but not directly mapped to the actions in the exergame. The mapping in Swim was imaginative in terms of it being a fish swimming in the exergame, which movements do not correspond to the swimming motion of a human, as the avatar moved forwards in more energetic bursts than a normal swimming stroke would lead to Similarly in Platform, the mapping was imaginative since the player did not have to jump off the ground for the avatar to jump in the game. The mapping was not as directly connected between motions and in-game actions for 2022 and Crossing in which lifting both arms corresponded to jumping (in Crossing) and to shooting (in 2022). Finally, in terms of highlighting rhythm, all four exergames highlighted rhythm by repeating similar movements over time. The rhythm was the most prevalent for Crossing and Swim in which consequent movements could be used to move in a fast pace, with Swim having slightly less rhythm due to sometimes pausing to rotate. Rhythm was slightly less prevalent in Platform, in which the timing of the jumps and change of direction was dependent on the platforms that varied in size, and in 2022, in which the player could choose to shoot at different time periods and the rhythm needed to perform well varied depending on the formation of the enemies.

2.3. Study setup

To evaluate the casual exergames sixteen participants were recruited based on a convenience sample. The participants were students who studied or had studied cognitive science (n=9), behavioral science (n=1), engineering (n=5) or economics (n=1). Thirty-one percent (n=5) were women and 69% were men (n=11), and their age ranged from 21 years to 27 (M=24). The participant where fairly active, exercising on average 104 minutes per week and being physically active 153 minutes per week. Three of the participants had no previous experience of exergames while five participants had used exergames several times or for longer periods and eight participants had only tried exergames on one occasion.

Before the gameplay, each participant was informed written and verbally about the purpose, procedure and data collection involved in the study, and that their answers would be treated anonymously and that they had the right to withdrawal from the study at any time without needing to convey a reason. All participants agreed and gave written consent to participate in the study. The participants (hereafter players) played all four exergames, where the order of the game played was changed for each player to avoid

bias generated from the order of playing each game. Before each exergame, the players got verbal instructions about the goal of the game and were shown which movements to use to play the exergame. Thereafter, the players had one minute to test the exergame and get support in case the exergame did not react to the movements, followed by two rounds of two-minute game play. While playing the exergame, players stood up approximately two meters away from of the computer screen set up in the lab. Some players, for which the exergames did not respond, were directed to change the distance to the computer in the test round. Following each game round, the players answered a questionnaire containing the Borg Scale of perceived exertion (Borg, 1982) and the Exergame Enjoyment Questionnaire (Fitzgerald et al., 2020). Following the survey, the players participated in a short five to ten-minute-long semi-structured interview concerning their experience of the exergame, before moving on to the next exergame following the same procedure. The interviews were semi-structured to be able to compare players' perceptions while at the same time diving deeper into interesting themes that emerged.

2.4. Materials and measures

The interview questions (Table 2.) following each casual exergame used general questions related to players perception of the exergame and specific questions related to exertion, movements, and responsiveness. To limit the analysis, the present work focused on the main aspects the players had mentioned in relation to their enjoyment and exertion in the casual exergames.

The exergame enjoyment questionnaire (EEQ) is a subjective measure of the participants enjoyment and includes questions based on four different categories; immersion, intrinsic reward, control, and exercise (Fitzgerald et al., 2020). The scale consists of 20 statements on a five level Likert scale for each statement, producing an overall score between 20 and 100 with a higher value indicating higher enjoyment. To the authors' knowledge the construct validity of EEQ has not been evaluated previously. The scale was chosen as it, to the authors' knowledge, is the only measure of enjoyment adapted specifically for the context of exergames.

The Borg rating of perceived exertion scale was chosen as a measure of exertion due to it being a valid measurement of perceived exertion (Chen et al., 2002) administered frequently when playing exergames (Barry et al., 2016; Höchsmann et al., 2016; Staiano & Calvert, 2011). The scale was developed as a self-reported measure to include various indications of physical strain (Borg, 1982). The scale ranges from 6 (no exertion at all) to 20 (maximum exertion), with a rating of 10-11 representing low intensity, 12-13 moderate intensity, and 14-16 high intensity (Mackinnon et al., 2003). Using the Borg scale to evaluate the exertion produced in the exergames thus indicates to what degree the participants experienced exertion directly after game play and the intensity in which exertion was experienced.

Table 2: Interview guide following each exergame

Interview questions
Have you played a similar game previously?
What did you think of the game?
What did you like about the game?
What did you not like about the game?
Did you encounter any challenges in the game? How did you experience that?
How did you experience the level of exertion in the game?
Why did you move the way you did during game play?
How did you experience the movements?

2.5. Analysis

Descriptive measures of exergame enjoyment and exertion were noted for each player during each game session to understand if the games had led to sufficient degrees of enjoyment and exertion. The descriptive statistics were complemented with the interview answers to get an in-depth understanding of players perception of each game. Each interview was transcribed word for word. To identify a common pattern from the interviews a thematic analysis was conducted following the method of (Braun & Clarke, 2006). The transcripts were read through thoroughly to familiarize oneself with the material. Thereafter codes with related citations were extracted for each exergame based on the guiding research question of how each exergame was perceived. Finally, codes based on all exergames were organized to cluster related topics into themes.

To understand what constitutes exertion and enjoyment in casual exergames we wanted to compare the level of exertion and enjoyment for the different exergames. Internal consistency for the EEQ-scale was analyzed with Cronbach's alpha for each exergame with an accepted value of 0.7 (Bland & Altman, 1997). The EEQ scale for each exergame extended the accepted value (with the lowest Cronbach alpha value being 0.78) and all questions were included in the final analysis. Two within-subjects repeated measures ANOVAs were run followed by post-hoc tests. Before each ANOVA was run, assumptions were accounted for in terms of outliers, detected as values three times the interquartile range either above the third quartile or below the first

quartile, and normality, detected using the Shapiro Wilk test statistic relevant for small sample sizes (Field, 2013). Bonferroni adjustments were applied for the post hoc analysis.

One clear outlier was detected for the EEQ scale for Platform. The value (38) was transformed using Winzoring (Kokic & Bell, 1994) converting the value to one score lower than the next lowest value (66). In addition, the highest score of Swim (83) was converted using Winzorising; converting the value to one score higher than the next highest value (75). No additional outliers were detected for the EEQ scores of Swim or of Crossing, nor for any of the Borg scales. The normality tests did not signal any deviations from the assumption of normality for neither the EEQ scales of each game, nor for the Borg scales of each exergame.

3. Results

3.1. Evaluation of enjoyment

The ratings of exergame enjoyment of the four different exergames (Table 3.) was high for three of the four exergames (Platform, Crossing, and 2022) (Figure 5.). The repeated measures ANOVA conducted to compare the exergame enjoyment score of the four different exergames showed a significant difference between at least two of the groups ($F(15, 3) = 11.812$, $p < 0.001$). Post hoc tests showed a significant difference between Platform and Swim ($MD = 16.03$, $p < 0.001$) and between 2022 and Swim ($MD = 12.38$, $p = 0.002$). There was no significant difference between Platform and Crossing ($MD = 4.56$, $p = 0.532$), Platform and 2022 ($MD = 3.69$, $p = 0.655$), Crossing and Swim ($MD = 11.50$, $p = 0.059$), or 2022 and Crossing ($MD = 0.88$, $p = 1.000$).

Table 3: Total EEQ scores for each casual exergame

Game	Average total EEQ Score (SD)
Platform	76.44 (10.85)
Swim	60.38 (9.03)
Crossing	71.87 (11.68)
2022	72.75 (9.30)

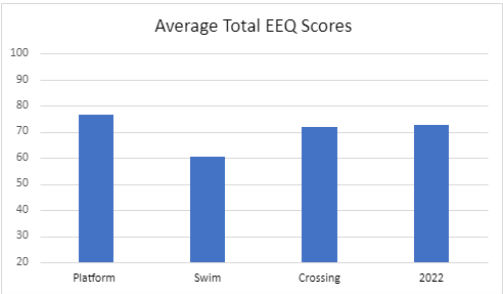

Figure 5. EEQ Scores

During the interviews, the participants expressed varied levels of enjoyment in the casual exergames. The Platform exergame was perceived as enjoyable by all except one participant (n=15). Most participants expressed that they had enjoyed Crossing (n=11) and 2022 (n=9), while only a few had enjoyed Swim (n=3).

Three main themes emerged related to the enjoyment of the casual exergames (Table 4.). The first theme related to the variation in the exergame, in which participants expressed **enjoying higher variation**. The participants had commented on enjoying the Crossing, Swim and 2022 less than the Platform exergame due to the low variation in the exergame. As one player expressed it: *"The Platform game was more fun, more interesting than playing the Crossing game, it felt like when you had jumped forward a couple of time, you had done everything"*. Variation was expressed both in terms of the graphical elements, the tasks, the game tempo, and the movements used. The second theme related to the game challenge. The participants had commented on enjoying the Swim exergame less compared to the other exergames due to the low challenge level and expressed **enjoying higher challenge**. In Crossing and 2022 participants expressed that they enjoyed the challenge introduced by the clear scoring system. In the Platform exergame players enjoyed the challenge introduced by new enemies appearing on the map and having to time their movements in relation to the exergame. In contrast to the other exergames, the participants commented on the Swim exergame lacking challenge due to not being able to fail:*" I felt like there were no stakes, I could swim around in the ocean, I did not feel like I had to put in an effort, it felt like I could lie on my back and paddle around rather than actively put in effort"*. The third theme related to the clarity of the rules and goals in the exergame, in which participants expressed **enjoying clear game mechanics**. The players commented on the Platform, Crossing, and 2022 game mechanics being perceived as clear due to their simplicity whereas the Swim game mechanics being perceived as less clear affecting their experience negatively. The clarity of the game mechanics was also related to the exergame themes, in which participants commented on the Platform and 2022 exergames being easier to understand and more enjoyable due to recognizing the game theme. In 2022 one participant mentioned: *"You understand that it is this type of game, I know what I should do, the question is only what the specific content will be, like type of enemies that shoot and enemies that shoot two times"*.

Table 4: Enjoyment themes

Theme	Casual game example
Enjoying higher variation	Higher variation in graphical elements, tasks, tempo, and movements in Platform
Enjoying higher challenge	The scoring system in Crossing and 2022. New enemies and timing of movements in Platform. Possibility to fail lacking in Swim.
Enjoying clear game mechanics	Simple game mechanics in Crossing, Platform and 2022. Relatable game theme in Platform and 2022.

3.2. Evaluation of exertion

The degree of exertion (Table 5.) was seen as satisfactory for Platform (moderate intensity) and Crossing (high intensity). However, the exertion for 2022 was at low intensity and Swim below low intensity and therefore seen as producing too low levels of exertion to what was deemed as satisfactory (Figure 6.). The repeated measures ANOVA conducted to compare the exertion score of the four different exergames also showed a significant difference between at least two of the groups ($F(15, 3) = 25.607$, $p < .001$). Post hoc tests showed a significant difference between Platform and Swim ($MD = 3.81$, $p < .001$), between Platform and 2022 ($MD = 1.81$, $p = 0.041$), between Crossing and Swim ($MD = 5.25$, $p < .001$), and between Crossing and 2022 ($MD = 3.25$, $p = 0.002$). There was no significant difference between Crossing and Platform ($MD = 1.44$, $p = 0.123$) or between 2022 and Swim ($MD = 2.22$, $p = 0.069$).

Table 5: Total Borg ratings

Game	Borg Score (SD)	Degree of exertion
Platform	13.00 (1.79)	Moderate intensity
Swim	9.19 (2.40)	Below low intensity
Crossing	14.44 (2.94)	High intensity
2022	11.19 (2.04)	Low intensity

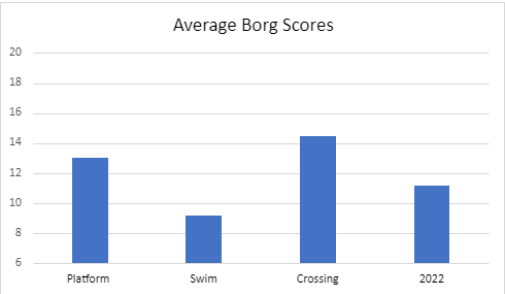

Figure 6. Borg Scores

During the interviews the participants had expressed experiencing exertion differently in the four casual exergames. The Platform exergame was overall viewed as exerting while Swim exergame was overall viewed as not exerting. In the Crossing exergame the participants had mentioned that the game was perceived as exerting but that the exertion was concentrated to the arms and the shoulders. For 2022, the participants conveyed varying amounts of exertion with some players finding the game exerting and others not finding it exerting. This could be explained by the fact that exertion was dependent on the gameplay. Players mentioned that they could choose how much they wanted to move in the game depending on how important it was for them to perform well.

Two main themes emerged related to the exertion of the casual exergames (Table 6.). The first theme related to the participants perceiving exertion as positive. The participants expressed seeing exertion as one of the main purposes of the game. In the Crossing exergame one of the participants expressed it in the following way: "*It became hard to do so many movements, which is good, because then you get the physical exertion, which is what you want to get out of the game.*". The participants also commented on appreciating the Platform exergame due to the exerting squat movement and becoming frustrated in the Swim exergame due to the low level of physical activity. In 2022, in which the exertion varied, participants mentioned a negative experience associated with low levels of exertion and a positive experience associated with higher levels of exertion. At the same time, there were some players in the Crossing exergame who had expressed that the level of exertion had been too high, leading to a feeling of fatigue and not wanting to play again. Furthermore, some participants had commented on appreciating that the Platform exergame utilized different body parts with varying degrees of exertion so that the game did not become too exerting. The second theme related to players desiring reward in relation to exertion. In Platform, Crossing and 2022 the participants had mentioned that they appreciated the fact that their performance increased if they were more physically active. After playing the 2022 exergame one player expressed: *"You can choose which planes you want to shoot and you can, if you are really fast, shot that one and then that one, you can choose if you want to move fast and in that way get more work out from it as well"*.

Table 6. Exertion themes

Theme	Casual exergame example
Perceiving exertion as positive	Expectations of high physical activity reached in Platform and Crossing due to large and/or intense movements but not Swim.
Desiring reward in relation to movements	Scoring system directly related to movements in Crossing. More movement required for high points in 2022. Having to time movements to succeed in Platform.

4. Discussion

4.1. Main contributions

The present work focused on considerations for casual exergames in terms of promoting both enjoyment and exertion. A comparison of the four casual exergames showed that a casual platform exergame (Platform) and a casual shooter exergame (2022) were perceived as more enjoyable compared to a casual exploration exergame (Swim), while Platform and Crossing were perceived as more exerting compared to 2022 and Swim.

Comparing the four casual exergames in adherence with the exergame guidelines offered by Isbister & Muller (2015), *the ambiguity of movements* had been the lowest for Swim which could have contributed to a less enjoyable game experience. In terms of *cognitive complexity*, both Swim and Platform required higher *cognitive complexity* compared to 2022 and Crossing. The *cognitive complexity* in Swim, introduced through the lower *ambiguity of movements* through requiring precise movements, differed from the *cognitive complexity* in Platform, introduced by a variation in graphical elements. From the interviews with players, low variation was associated with lower enjoyment. Apart from game elements, we found that variation could also be introduced in casual exergames through the tasks presented to the player, the tempo in the exergame, and the movements utilized. At the same time introducing *cognitive complexity* through having less *ambiguity in movements* might impact players experience negatively. Participants had also enjoyed the causal exergames with clear game mechanics, aligned with the principles for casual game play of designing games that are easy to learn and that have simple controls *(Casual Game White Papers IGDA, 2008)* and with reducing *cognitive complexity* (Isbister & Mueller, 2015). As in the context of casual games (*Casual Game White Papers IGDA*, 2008), we found that including a well-known game genre and simple game mechanics could enable the players to recognize and understand the game mechanics more easily (*Casual Game White Papers IGDA*, 2008).

To align with the guidelines of *focus on the body* (Isbister & Muller, 2015) all four casual exergames included a high-paced game play, however this was the lowest for Swim in which no threat faced the player. Furthermore, while Swim was initially intended to *highlight rhythm* this process was restricted during game play due to the low ambiguity of movements. Similar to other exergames (Lyons, 2015), high challenge was perceived as enjoyable by the participants. This is somewhat contradictory to the principles of casual games, which advocate a forgiving and non-punishing game play (*Casual Game White Papers IGDA*, 2008). However, the results suggest that too forgiving game play was perceived as negative. The results indicate that balancing movements and game challenge (Isbister & Mueller, 2015) while keeping the game non-punishing (*Casual Game White Papers IGDA*, 2008) should be done carefully, where the player can still fail in some ways. Apart from including the ability to fail we found that challenge could be introduced in casual exergames through having a clear scoring system (as in Crossing and 2022) and by introducing more challenging game elements over time (such as in Platform)

The appreciation of challenge was also related to the physical challenge, which corresponds to the guideline of *intended fatigue* (Isbister & Mueller, 2015). For example, in Swim, where exertion had been low, the players became frustrated while in Crossing and Platform, where exertion was higher, the players had mostly appreciated the physical exertion. While the intended fatigue guideline for exergames emphasizes balancing exertion over time (Isbister & Mueller, 2015) due to promoting the hedonic nature of exergames (Subramanian et al., 2020), we found that exertion was overall perceived as positive by participants of the study. A more consistent physical challenge might therefore be more applicable to casual exergames, possibly due to their short duration. At the same time some players had commented on the exertion being too high in Crossing, indicating that the exertion should be balanced with the players physical ability (Sinclair et al., 2009).

Crossing and 2022 were similar in terms of *movement ambiguity* and number of unique movements. However, Crossing introduced a higher physical game challenge since the player had to constantly perform tiring movements to survive in the game while 2022 had *higher cognitive complexity* due to making decisions about which enemies to go after. Swim, requiring less *ambiguity in movements* through requiring precision, and consequently *higher cognitive*

complexity had the lowest exertion due to the extended periods in which the participants needed to stand still. Participants had also commented on desiring rewards in relation to the movements performed, which could be a way to encourage the exertion and consequently the utilitarian benefits associated with casual exergaming. Furthermore, the rewards in relation to movements could be a way to distract players from feeling tired by bringing down the *focus on the body*.

Based on the results of the present study we highlight the need for casual exergames to 1) Allow for higher ambiguity of movements, as a low ambiguity in movements can result in too high cognitive complexity, less rhythm, and too much focus on the body. For casual exergames, having too low ambiguity of movements could potentially be even more detrimental than in longer traditional exergames, as the short game play does not allow players to learning precise movements over time (for hedonic purposes), and since lower ambiguity of movements risks resulting in lower exertion (for utilitarian purposes). 2) Introduce a balances level of cognitive complexity through keeping clarity in game mechanics while introducing complexity through a variation in graphical elements, tasks, tempo, and movement complexity (for hedonic purposes) while encouraging fatigue (for utilitarian purposes). For casual exergames, that are simple in their nature compared to traditional exergames, a more careful consideration might need to be taken to ensure that the complexity of the game does not become too low. Furthermore, compared to traditional exergames, casual exergames should always emphasize fatigue to reach sufficient levels of exertion during the short game play. 3) Direct players attention from the body by utilizing a fast game pace, in which players can become challenged psychologically (for hedonic purposes) and physiologically (for utilitarian purposes). For casual exergames, compared to traditional exergames, directing attention from the body might be especially important to be able to encourage sufficient levels of exertion as they cannot reach exertion through longer durations of more careful gameplay.

4.2. Limitations and further research

The purpose of the present work was not to provide design principles but instead provide considerations and recommendations. The results of the study should be viewed in light of the specific casual exergames that were designed, developed, and evaluated. Including other casual exergames could have produced other findings that are important to consider in the design of casual exergames to promote exertion and enjoyment. We therefore encourage further research to explore design considerations in the context of other casual exergames with different design solutions. Furthermore, the present study included casual exergames played during 4-minute increments in total and might therefore not be applicable to casual exergames with longer durations, e.g., 10 minutes of game play. Further studies should therefore be conducted with casual exergames of varying lengths. The present study also included participants of similar demographics, mostly students with a similar age range. Further studies should therefore investigate if the findings are applicable to other demographics. The small sample size (n=16) and the case design nature of the study also limits the generalizability of the results. Further studies should therefore investigate the findings of the present study quantitatively with several different casual exergames. Finally, there is a need for longitudinal studies on exertion and enjoyment of casual exergames and how they should be designed to promote exertion and enjoyment over time, since the present study only included players' initial experience with the casual exergames.

5. Conclusions

The present study explored design considerations in order to promote exertion and enjoyment in casual exergames. Based on a comparison of the casual exergames we highlight three main aspects that should be considered in relation to previous exergame guidelines in the design of casual exergames to promote both exertion (for utilitarian purposes) and enjoyment (for hedonic purposes): allow high ambiguity of movements; introduce a balanced level of cognitive complexity through clear game mechanics and high variation and fatigue; and direct players' attention from the body by utilizing fast game pace.

6. References

Adams, E. (2014). *Fundamentals of game design*. Pearson Education.

Barry, G., Van Schaik, P., MacSween, A., Dixon, J., & Martin, D. (2016). Exergaming (XBOX Kinect™) versus traditional gym-based exercise for postural control, flow and technology acceptance in healthy adults: a randomised controlled trial. *BMC sports science, medicine and rehabilitation*, *8*, 1-11.

Berglund, A., Jedel, I., Orädd, H., & Berglund, E. (2023). The Attractiveness and Effectiveness of Upper Body and Full Body Casual Exergame Controllers. 11th International Conference on Serious Games and Applications for Health, SeGAH, IEEE,

Berglund, A., Jedel, I., Orädd, H., Fallström, J., & Berglund, E. (2023). Liopep: A Gamified Casual Exergame Application to help Office Workers not be Active Couch Potatoes. IEEE 11th International Conference on Serious Games and Applications for Health, SeGAH, IEEE,

Berglund, E., Jedel, I., Orädd, H., Fallström, J., & Berglund, A. (2023). The Effect of Assigned Goals in Casual Exergames on Performance, Exertion and Enjoyment. 11th International Conference on Serious Games and Applications for Health, SeGAH, IEEE,

Bland, J. M., & Altman, D. G. (1997). Statistics notes: Cronbach's alpha. *Bmj*, *314*(7080), 572.

Borg, G. A. (1982). Psychophysical bases of perceived exertion. *Medicine & science in sports & exercise*.

Braun, V., & Clarke, V. (2006). Using thematic analysis in psychology. *Qualitative research in psychology*, *3*(2), 77-101.

Casual Game White Papers IGDA. (2008). (International Game Developers Association, Issue.

Chau, J. Y., Grunseit, A. C., Chey, T., Stamatakis, E., Brown, W. J., Matthews, C. E., Bauman, A. E., & van der Ploeg, H. P. (2013). Daily sitting time and all-cause mortality: a meta-analysis. *PloS one*, *8*(11), e80000.

Chen, M. J., Fan, X., & Moe, S. T. (2002). Criterion-related validity of the Borg ratings of perceived exertion scale in healthy individuals: a meta-analysis. *Journal of sports sciences*, *20*(11), 873-899.

Dutta, N., & Pereira, M. A. (2015). Effects of active video games on energy expenditure in adults: a systematic literature review. *Journal of Physical Activity and Health*, *12*(6), 890-899.

Ekelund, U., Steene-Johannessen, J., Brown, W. J., Fagerland, M. W., Owen, N., Powell, K. E., Bauman, A., Lee, I.-M., Series, L. P. A., & Group, L. S. B. W. (2016). Does physical activity attenuate, or even eliminate, the detrimental association of sitting time with mortality? A harmonised meta-analysis of data from more than 1 million men and women. *The lancet*, *388*(10051), 1302-1310.

Field, A. (2013). *Discovering statistics using IBM SPSS statistics* (4th ed.). sage.

Fitzgerald, A., Huang, S., Sposato, K., Wang, D., Claypool, M., & Agu, E. (2020). The exergame enjoyment questionnaire (EEQ): An instrument for measuring exergame enjoyment. Proceedings of the 53rd Hawaii International Conference on System Sciences,

Gao, Y., Gerling, K. M., Mandryk, R. L., & Stanley, K. G. (2014). Decreasing sedentary behaviours in pre-adolescents using casual exergames at school. CHI PLAY 2014 - Proceedings of the 2014 Annual Symposium on Computer-Human Interaction in Play,

Gao, Y., & Mandryk, R. L. (2011). GrabApple: the design of a casual exergame. Entertainment Computing–ICEC 2011: 10th International Conference, ICEC 2011, Vancouver, Canada, October 5-8, 2011. Proceedings 10,

Gao, Y., & Mandryk, R. L. (2012). The acute cognitive benefits of casual exergame play. Proceedings of the SIGCHI Conference on Human Factors in Computing Systems,

Hicks, K., & Gerling, K. (2015). Exploring casual exergames with kids using wheelchairs. Proceedings of the 2015 Annual Symposium on Computer-Human Interaction in Play,

Höchsmann, C., Schüpbach, M., & Schmidt-Trucksäss, A. (2016). Effects of exergaming on physical activity in overweight individuals. *Sports Medicine*, *46*, 845-860.

Isbister, K., & Mueller, F. (2015). Guidelines for the Design of Movement-Based Games and Their Relevance to HCI. *Human-Computer Interaction*, *30*(3-4), 366-399. https://doi.org/10.1080/07370024.2014.996647

Kokic, P., & Bell, P. (1994). Optimal winsorizing cutoffs for a stratified finite population estimator. *JOURNAL OF OFFICIAL STATISTICS-STOCKHOLM-*, *10*, 419-419.

Lachman, M. E., Lipsitz, L., Lubben, J., Castaneda-Sceppa, C., & Jette, A. M. (2018). When adults don't exercise: Behavioral strategies to increase physical activity in sedentary middle-aged and older adults. *Innovation in aging*, *2*(1), igy007.

Lyons, E. J. (2015). Cultivating engagement and enjoyment in exergames using feedback, challenge, and rewards. *Games for health journal*, *4*(1), 12-18.

Mackinnon, L. T., Ritchie, C. B., Hooper, S. L., & Abernethy, P. J. (2003). *Exercise management: concepts and professional practice*. Human Kinetics.

Mueller, F. F., Gibbs, M. R., & Vetere, F. (2008). Taxonomy of exertion games. Proceedings of the 20th Australasian conference on computer-human interaction: designing for habitus and habitat,

Sinclair, J., Hingston, P., & Masek, M. (2007). Considerations for the design of exergames. Proceedings of the 5th international conference on Computer graphics and interactive techniques in Australia and Southeast Asia,

Sinclair, J., Hingston, P., & Masek, M. (2009). Exergame development using the dual flow model. Proceedings of the Sixth Australasian Conference on Interactive Entertainment,

Staiano, A. E., & Calvert, S. L. (2011). The promise of exergames as tools to measure physical health. *Entertainment computing*, *2*(1), 17-21.

Subramanian, S., Skjæret-Maroni, N., & Dahl, Y. (2020). Systematic review of design guidelines for full-body interactive games. *Interacting with Computers*, *32*(4), 367-406.

Yoo, S., Gough, P., & Kay, J. (2020). Embedding a VR game studio in a sedentary workplace: use, experience and exercise benefits. Proceedings of the 2020 CHI Conference on Human Factors in Computing Systems,