The Effects of Juicy Game Design on Exergames

by

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Author's Declaration

I hereby declare that I am the sole author of this thesis. This is a true copy of the thesis, including any required final revisions, as accepted by my examiners.

I understand that my thesis may be made electronically available to the public.

Abstract

Visual embellishments (VEs) have been increasingly included in most modern video games and in various digital applications. One aspect of these graphical inclusions is called Juicy game design. It refers to user feedback that is not integral to game completion presented through a variety of modalities. Previous research on this topic has provided insight into some effects of juicy game design, however there is a lack of understanding of the thresholds between different levels of embellishments.

For the purpose of my thesis work, my research addresses how various levels of visual embellishments affect participants' perceived enjoyment of exercise media and how embellishments affect participants' motivation to exercise. It aims to explore the overall implications of juicy game design in an exercise game setting. To accomplish this I conducted a detailed survey study with three different levels of juicy design - High, Medium and Low, using the exergame *Sphery Racer* as a basis for the graphics.

Participants (N=100) were recruited from Prolific[1] in which I administered the PANAS scale, Godin Leisure-Time Exercise Questionnaire, and a comparison task on Qualtrics[2].

Through my statistical analysis, my results show enjoyment of media is heavily tied to whether or not there is any presence of embellishment however once a certain embellishment threshold is passed enjoyment does not continue to increase. In some cases, less visually embellished stimuli are favourable as an encouragement to work out more frequently, however, result in an overall more boring and lacklustre experience. Through these findings, I was able to validate previous research and add additional insight to the field of exergame design.

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[1]Prolific: Allows the researcher to quickly find participants which allows for rigorous checks and unbiased screening.

[2]Qualtrics: Qualtrics is a powerful online survey tool that allows one to build surveys, distribute surveys and analyze responses.

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Dedication

Dedicated to my family, who are always there to bring light into my life and offer a helping hand.

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Chapter 1

Introduction

Flashy animations, detailed graphics, and bright effects can be found in many video games. The term "juicy" was popularized by an online rapid game prototyping guide where Kucic [38] describes the concept like this: "A juicy game element will bounce and wiggle and squirt and makes a little noise when you touch it. A juicy game feels alive and responds to everything you do—tons of cascading action and response for minimal user input" [38]. Juicy game design suggests games can be made more engaging and fun by using audiovisual design elements such as juicy graphics and engaging sounds[35]. The idea is that these elements can help to create a more immersive and enjoyable experience for players. A game that is not juicy, can still be mechanically enjoyable, however, it will appear minimal in graphical, audio and haptic responses upon user input.

Juicy game design has been shown to improve the in-game player experience and create a positive impact on the overall perception of the game [4, 27, 54]. Juicy game design and embellishments have also positively influenced data viewing, understanding, and information recall [4, 5, 6]. This makes it an effective supplement to educational platforms such as the learning tool *Duolingo*[1].

Additionally, juicy game design influences impression, perceived competence, and in some cases encourages players to explore within the game context [27]. These subtle enhancements add more meaning and create a more immersive experience for players [27]. In their study of visual embellishments (VEs) in games, Hicks et al. [27], determined "juicy design facilitates more immersive experiences, suggesting that VEs help players to become more engulfed in an experience, which could be leveraged to increase engagement or pique initial interest". This makes juicy game design especially effective for games and

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[1]Duolingo: https://www.duolingo.com/

applications that require higher levels of immersion and focus. Juicy game design can make a game more engaging by adding elements that are visually stimulating, exciting to interact with, and challenging enough to keep players engaged.

One game type that may particularly benefit from the advantages of juicy game design is fitness or exercise games, also referred to as exergames. Juicy game design may result in better health outcomes as players are more likely to keep an exercise routine if they feel increased immersion and motivation to keep playing[19]. Finco and Maass [17] describes exergames as "video games that include any type of physical exercise in the game routines. Exergames have shown the potential to motivate people of many ages and abilities to begin exercising [69]. Although they have been around since the 1980s, there is still much to be learned about the influence of graphical design decisions and how they can be made more effective for their users [17]. I believe exergames are a great way to get people moving and motivated and juicy game design can help make exergames even more enjoyable and effective at getting people into physical activity, which can lead to individual health improvements.

Recently released exergames such as *Beat Saber* [2], *Ring Fit Adventures*, *Beat Saber* , and *ARMS*™ [3] have included more visually robust games displaying abundant user feedback. Examples of the visual feedback mentioned can be observed in Figure 1.1, Figure 1.2, Figure 1.3, and Figure 1.4 of the games mentioned above. *Beat Saber*, which is played in a Virtual Reality (VR) environment uses faded streaks of colour, bursts of colour exposure and particle effects to indicate player movement and contact. Once broken, bits of blocks fly off the screen adding to the effect of the force in the user's action.

Ring Fit Adventures takes a different in-game approach and has many mini-games that are a part of a greater storyline. Each mini-game places focus on a different exercise target area and uses much visual feedback to reinforce player actions. Figure 1.2 illustrates the immense effect that user action has on in-game elements. Given this is a strength-based exercise, dramatic environmental reactions make sense to reinforce the impact the user has on the in-game task they are given.

Other games, such as and *Just Dance*[4], have focused less on user feedback graphics and more on game environment graphics such as background animations.

For example, the 2012 release of *Just Dance* placed emphasis on more prominent score and progress feedback animations. User interface elements were prioritized over the dance animation with player ranking, progress, and success rate taking up the majority of screen

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[2]Beat Saber: https://www.beatsaber.com/

[3]ARMS™: https://www.nintendo.com/store/products/arms-switch/

[4]Just Dance: https://www.ubisoft.com/en-us/game/just-dance/2022/
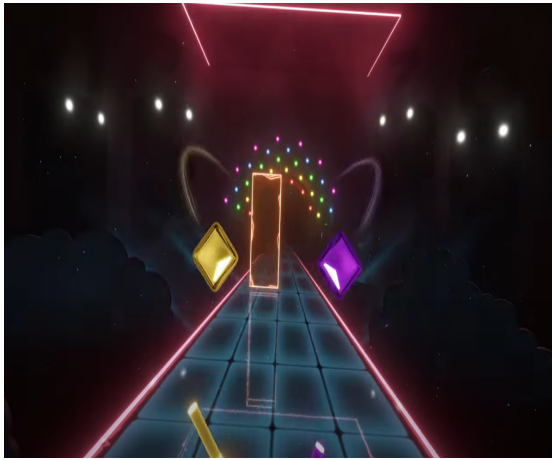
(a) Approaching beat target blocks

(b) Interaction animation upon impact

Figure 1.1: Screenshots from *Beat Saber*

(a) Example of broken blocks exploding

(b) Interaction animation upon impact

Figure 1.2: Screenshots from *Ring Fit Adventures*

space. Figure 1.3b shows the game response to successful action completion, with some particle effects blooming from the "PERFECT" badge displayed on the screen. These effects are also accompanied by a sound cue to indicate the achievement of a perfect score.

Just Dance 4 prioritized player (UI), the upcoming version of *Just Dance 2023*, seems to do the opposite. Furthermore, the game's developers seem to have placed less emphasis

(a) Visual elements before user action   (b) UI player feedback animation

Figure 1.3: Game-play screenshots from *Just Dance 4*

on giving players feedback and the game triggers high-volume embellishments based on predetermined in-game timers. In Figure 1.4b, the screen glows at a key musical moment. The game shows feedback at the top of the screen based on how successfully the player performed the moves. This user interface element includes a small word-based animation and random/occasional particle effects. Compared to the earlier version of the game shown in Figure 1.3, the screen has more space around the dancer (i.e., it feels zoomed out) and places focus on the in-game dancer animation.

The two game versions differ in how their graphical user interface elements have progressed. Both versions include juicy user interface elements and use them to highlight different key moments of the game. The older version places emphasis on scores and achievements, creating a more competitive environment. Compared to the upcoming version, which focuses on emphasizing song elements and rhythmic features. These changes resulted in a more experiential and music-centred experience.

The differences in approaches within the exergames mentioned above result in significantly different game feelings and experiences. With many juicy game design elements already being an essential part of available exercise games, it is crucial to have an understanding of how these elements influence the player experience. Additional research and a better understanding of the role elements of juicy game design play in exergame experience, the potential of exergames becomes quite significant.

Currently, little is known about application guidelines for juicy game design. As a

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(a) Visual elements before user action   (b) User action and game animations

Figure 1.4: Screenshots from *Just Dance 2023*

result, game designers creating these elements do so according to their own judgment. Such implementations may be aesthetically pleasing but come at the cost of unintentionally impacting player experience.

1.1   The Role of Visual Embellishments

The additions of animations and graphic embellishments were studied in an educational context with a focus on cognitive load and its effects on learning [18, 34, 66]. The effectiveness of the different animation types was shown to vary with existing learner knowledge [18, 34, 66]. Although the purposes of implementing educational animation and visual juicy design differ, both rely on graphical elements to supplement information. Considerations applied to educational animations may need to be applied to juicy game design as well. Similar user experience pitfalls in information processing have been identified in highly embellished juicy designs. Research conducted on juicy game design levels has shown negative effects when the visual embellishments were applied with too much or not enough [35]. Incorrect understanding of user expectations has also been shown to lead to some dissatisfaction in the overall experience [54]. For example, if an in-game character is shooting fireballs, but the sound being emitted resembles bubbles that becomes a mismatch of expectations and creates a degree of confusion within the player.

The magnitude, timing, placement, and frequency of juicy game design is often left to

the game designer's discretion because of the lack of resources and guidelines available. The details of juicy delivery components are highly understudied. Understanding the impact of these elements in detail can help our understanding of the determinants of satisfying experiences, and mitigate effects of disadvantageous combinations or components.

The research within my thesis aims to explore a greater understanding of visual design elements within exergames in order to better guide effect implementation. My research shows enjoyment of media tied to whether there is any presence of embellishment. Although, enjoyment does not increase with the number of visual embellishments present. It was also found that less visually embellished stimuli appear favourable to participants as an encouragement to work out more frequently. Visual embellishments also result in an overall more boring and lacklustre experience.

In this thesis, I am considering current exergame technology and game models for Juicy Game Design. Hence, its goal is to create a better understanding of the effects of different visual embellishments on player engagement.

1.2   Motivation

Lack of physical fitness rests at the heart of many larger health issues that are both physical and mental in nature. With many jobs becoming desk-bound, adults are spending more time sitting during their workday [51]. Children are also experiencing similar tendencies. Although schools in Ontario include some moderate physical education in their curriculum, out-of-school hobbies are slowly being reduced to indoor activities, where kids sit either on a couch or in front of a computer. This is the lifestyle gap in which exergames have the potential to do much good and revolutionize how everyone views exercise and their commitment to their health.

Over the pandemic, fitness games *(otherwise known as exergames)* have received increased attention. They provided a fun alternative to people's existing fitness habits that broke down because of stay-at-home mandates. Organizations like the World Health Organization (WHO) have also recognized and even encouraged using exergames to motivate creating new fitness habits fitting into the pandemic constraints [63]. Amidst the media attention, interaction design researchers have recognized exergames to be therapeutic and mentally stimulating applications with emphasis on the physical and human movement aspects of exergame design [69]. There exist a research gap for understanding the mental and cognitive side of exergame design.

Understanding the effects of design elements is integral to creating a more user-centred

design. The effects of embellishment and juicy design implementation have been explored in the past, leading to some understanding of their influence [3, 27, 35]. That being said, exergames and an exercise-based context create a unique situation of physical stimulation and at times adrenaline that may result in a change in human perception of such elements. Building an understanding of these design elements and visual factors could create more informed designs and result in better exergame design [12, 21].

Accessible and engaging indoor recreation is becoming increasingly important [2, 13, 51]. From difficulty finding viable exercise options in winter and snowy or rainy conditions to seasonal allergies in the spring and summer, exergames offer an opening to maintain consistent exercise habits.

1.3   Research Questions

My thesis aims to address two research questions:

RQ1: How do various types of embellishments affect participants' perceived enjoyment of exercise media?

RQ2: How do embellishments affect participants' motivation to exercise?

From exploring the above research questions, I make the following contributions in this thesis:

- The addition of juicy game design was shown to be significant as measured by user ratings and the PANAS. Notably, the difference between the Medium condition (with some levels of embellishment) and the High condition (with full animations and particle effects were not significant). This indicates participant enjoyment does not increase with the number of visual embellishments present but has a threshold. This is further discussed in chapter 5.

- Although not as enjoyable, fewer embellishments were advantageous for participants who valued a focused environment with minimal visual distractions, such as a gym. Lower levels of juicy game design were also chosen significantly more often than the High and Medium conditions when asked which would encourage participants to work out more frequently.

1.4 Structure of Thesis

This thesis is organized into the following remaining chapters:

In *Chapter 2*, I review the literature surrounding the topics of juicy game design and embellishments, as well as their role in the design process. I briefly examine exergames and familiarize the reader with examples of existing exergames as well as the gameplay elements integral to functioning exergame systems to provide context for the rest of the thesis.

In *Chapter 3*, I walk through the methodology and design choices implemented throughout the study design as well as the survey design used to collect data on the perception of juicy design elements in exergames. I also explain the statistical methods used for the analysis of the data.

In *Chapter 4*, I present the results of the survey study beginning with reporting a repeated measures non-parametric ANOVA for the Positive and Negative Affect Scale PANAS [65]. Next, I go over the results of the juicy conditions comparison section of the survey and illustrate participant preferences.

In *Chapter 5*, I connect the study findings to the existing context of the previously conducted research and discuss the implications of juicy influence on future exergame design, as well as its role in user-centred design and situational applications.

Finally, in *Chapter 6* I revisit the research questions once again and summarize the contributions of this thesis, discuss the limitations of the research and provide an outline of the next steps for future work.

Chapter 2

Related Work

2.1 Embellishments

The use of embellishments has been present in human expression through art for countless years and has since been adapted to electronic and educational use. Borgo et al. [11], describe visual embellishments as "a form of non-linguistic rhetorical figures that can be seen frequently in the visual arts, performing arts, advertisements, icons and signs, culture symbols, color symbolism, graphical user interfaces, and so forth". The effectiveness and uses of visual embellishments in media have been often questioned in terms of their ability to convey information without distractions and overwhelming the user [6, 11]. Tufte advocates for data visualization that is "to-the-point" in which does not cause misleading interpretations from visual embellishments (VEs) [61]. Although many of the guidelines presented by Tufte still hold true, further research has shown that there is a time and circumstance for embellishment application in information visualization and other media [5, 6, 11, 53]. Embellishments are helpful for creating more enjoyable experiences while observing data visualization while increasing the memorability and recall effects of the information presented [5, 6, 40]. This can be effectively used in educational contexts where memorability is more important than timely interpretation [5, 53], however, where quick interpretation is needed embellishments have been shown to have adverse effects [6, 40]. The same cannot be said for in-game applications, where research has shown that higher graphic fidelity creates more enjoyable experiences for players compared to more minimalist graphics [20]. This is perhaps a result of the expectation for immersion when users engage in games that are otherwise not present when examining data visualizations [20]. In this way, game research presents a unique opportunity in the field of Human-Computer Interaction

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(HCI) to understand the relationship between how users experience embellishments through different stimuli.

Throughout this thesis, when referring to juicy game design in the context of the created conditions, I will be exclusively be referring to the visual aspect of juicy game design or in other words visual embellishments (VEs).

2.2   Juicy Game Design

Juicy game design has been around for several years and has been intuitively included in many early games. However, Kucic [38] described the juicy game design as "constant and bountiful user feedback" that "feels alive and responds to everything you do – tons of cascading action and response for minimal user input. It makes the player feel powerful and in control of the world, and it coaches them through the rules of the game by constantly letting them know on a per-interaction basis how they are doing".

Researchers began to look at juicy game design through an academic lens with the goal of understanding the boundaries [35], and effects of using juicy design on user motivation [28], and general enjoyment [4, 27, 35]. The findings from these works will be discussed in further detail below.

Previous research surrounding juicy game design has made it hard to find much consensus on the topic. This is largely due to the subjective nature of juicy design and the lack of formal guidelines surrounding the topic and its application.

2.2.1   Uses for Juicy Design

In 2013, Atanasov [4] examined juicy design in hopes of synthesizing a meaning for a term to be used in academic contexts. Through user studies exploring different levels of Juiciness he was able to conclude that "the quality of *Juiciness* defines conditions that foster a positive emotional response, a feeling of reward and satisfaction and an overall enjoyment of being within the game world." He goes on to conclude that "juiciness should not be considered as an ultimate leverage point of what a good design is. Instead, it should be taken for what it is – a language around a thought process of designing with experience in mind", indicating that although currently based in the context of game design, juiciness as a design tool can be an impact tool for reinforcing user experiences.

Atanasov's findings are further supported by Hicks, who found similar results when examining juicy game design and player experience [27]. Through an initial study with 40

participants, the research shows "juiciness improves the aesthetic appeal of both games, but does not have the anticipated effects on the satisfaction of psychological player needs, and no implications for player performance" [27]. A follow-up study was also conducted using a different game with additional conclusions. The research determined that Juicy game design influences largely impression, perceived competence, and in some cases encourages players to explore within the game context.

In line with the findings mentioned above, Singhal and Schneider [54] found similar results when studying haptics and Juicy game design. Juicy haptics were able to slightly affect aesthetic appeal, immersion, and meaning, but the authors concluded "the inclusion of vibrotactile embellishments can enhance player experience (PX), but we did not find much significant difference between the low and high juicy haptic conditions on PX constructs". Once again, it is shown that although embellishments are not the most impactful when it comes to user experience, they provide subtle enhancements that improve player impressions [4, 27, 54].

Both visual embellishments and juicy game design have been shown to create more enjoyable experiences for data viewing and application use [4, 5, 6]. Both have the potential to create more interest in the information they are portraying, better understanding, and longer retention of information [5, 6]. The application of these design tools can be effective anywhere where there is an abundance of information being presented or difficulty with engagement and attention as they create an avenue of curiosity in their use.

2.2.2 Juicy Design Pitfalls

Kao [35] conducted a study that examined how various intensities of juicy game design impacted PX, intrinsic motivation, motivation with time, and game performance. The study (N=3018) compared "four identical versions of an action role-playing game with varying amounts of juiciness: 1) None; 2) Medium; 3) High; and 4) Extreme" [35]. Results indicated both minimal and extreme amounts of juiciness had negative impacts on PX, intrinsic motivation, motivated behaviour and performance of players. Although it became clear that a complete lack of embellishments was similar in detriment to overuse of embellishments, Kao [35] was able to conclude with a high degree of certainty that "Medium Juiciness and High Juiciness outperform No Juiciness and Extreme Juiciness across virtually all measures".

In their thesis on productive and unproductive friction in-game design [58], Sung builds on Kao's research and uses very high levels of juicy game design to create unproductive friction in a word-matching game. Their findings show participants performing worse in

the condition with higher levels of juiciness, as well as experiencing distraction and feelings of anxiety.

Visual embellishments (VEs), could be considered as one of the components that make up juicy game design [27, 35]. There are parallels between juicy game design and visual embellishments when looking at negative use case scenarios. Both methods are susceptible to overstimulating users and causing an overload of information [6, 11, 35, 58]. This leads to potential misuse when not applied properly, and with limited studies on the penalization of both visual embellishments and juicy game design these elements should be carefully planned and thought out before implementation.

2.2.3   Juicy Design Applications

Juicy design has been paired with concepts such as gamification in a virtual reality context to bring a better understanding of the potential of both methods to have influences on participant behaviour. In this study, participants (N=36) were asked to play a game called *Predator!* with four separate conditions including (Base, Juicy, Gamified, and Combined), then answer questionnaires on PX and motivation. They found that while "*traditional* (i.e., commonly applied) gamification elements focus on performance (e.g., through leaderboards), elements of juicy design leverage real-time feedback to inform users about achievement and make them feel more connected with the system with both approaches effectively complementing each other. Hicks et al. [28], therefore, suggests "explicitly incorporating juiciness in the definition of gamification as an approach that leverages the application of game elements in non-gaming settings".

Game audio research has shown that audio is an important aspect of experiencing games and can be a driving factor behind immersion [49]. It is no surprise then that juicy audio has become of interest to researchers. Smets and van der Spek [56] explored juicy audio and found "juicy sound, operationalized in this study as more polish to the sound, can contribute to a greater feeling of presence in the player", this means the player felt more impact and immersion from their actions. They also identified themes within the research that showed user experience was heavily tied to whether or not the sounds aligned with existing expectations. They also found that sound has a significant influence on in-game player feedback, and it is not always interpreted the same way [56]. Similar areas within the field have shown audio has little effect on experience [3]. Researchers studying audio effects in gamified systems found little significance between audio-embellished and non-embellished conditions. These findings lead researchers to believe that more studies need to be conducted in the area [3, 56].

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There has also been exploratory research into juicy element generation within a game context that thus far has shown much potential for industry and research use cases [31, 32]. This opens up avenues for a greater understanding of Juicy game design through faster iteration cycles.

2.3   Exergames

Games and exercise have coincided with each other throughout history in the form of organized sports. With the peak of the digital era, games, exercise and tech have been merged together to form digital exergames. With the flexible and forgiving nature of different platforms and digital tools, fitness games were given the ability to take on many shapes, styles and aesthetics [15, 67, 68].

Exergames range from player vs player, console, arcade-style games, phone audio-based, augmented reality (AR), virtual reality (VR), and other single-player games. They often target a variety of fitness topics such as balance, flexibility, range of motion, strength, cardio and coordination [26, 39, 48, 57]. Finco and Maass [17] defines, "exergames are a type of video games that include any type of physical exercise in the game routines. It is possible to include also physical activities involving a capture system of movements of activities such as dance and sports. Exergaming or exergames practice is the act of use of this type of video game to work out".

The design of exergames has an important impact on how they are perceived and used by a variety of different users [36, 42, 68, 70]. Mueller et al. [46], began with creating a taxonomy of exergames with the goal of ameliorating theoretical knowledge and focusing on the Human-Computer Interaction (HCI) aspect of exergames, rather than the technical aspect. Although the taxonomy does not address design elements of exergames and what makes such games effective, they do categorize different exergames and provide a game feature framework.

In the following years, Isbister & Mueller [29], created design guidelines that were then validated by consulting experts within the field of movement-based game design, receiving internal feedback, and recruiting participants with relevant expertise. The final guidelines included three main clusters that target different aspects of the exergame experience. The first: Movement Requires Special Feedback includes guidelines that guide designers in ensuring the physical movement to in-game action is well-translated and enjoyable to the player. In this section, designers are briefly warned against overwhelming users with visuals and on-screen feedback as it can take away from the necessary focus needed to perform the

required physical tasks [29]. This draws some parallels to research previously conducted surrounding the topic of overwhelming Juicy game design elements [35], but with different implications as Juicy elements have not yet been formally examined in an exergame context.

Such research is a worthwhile endeavour, exergame have been shown to be an enjoyable form of exercise that has proven to be on par with other more established forms [60]. The effects of VR exergames were compared to treadmill running and examined through the lens of overall user experience with a focus on heart rate, rated perceived exertion, motivation to exercise and time spent exercising [60]. The study found that although exergames resulted in an overall lower mean heart rate, the most active 20-minute period of each exercise showed nearly identical heart rates of 148.61 for exergames and 148.17 on the treadmill. In the intrinsic motivation section of the study, the researcher used the Intrinsic Motivation Inventory [52] and was able to see overall higher ratings for the exergames than on the treadmill. They conclude their work by stating, "the exergame *Beat Saber* [1] can be considered a viable, alternative form of exercise that is also more engaging than running on the treadmill" [60].

2.4   Summary

There exists some consensus on what amounts of embellishments create good and bad juicy game design. For example, over-the-top embellishments have been found to be hard to focus on and detrimental to user experience [35, 58]. User expectations and intuition for where embellishments are expected and how they occur also play an important influence on how the effects will be perceived [35, 54]. For example, the uses of visual embellishments in media have been often questioned in terms of their ability to convey information without distractions and overwhelming the user. Research also shows that although juicy game design does not significantly influence performance, however, it does create better game impression and immersion [27, 36, 54].

Using the research that has already been conducted by exergame researchers in the field, this work aims to provide an initial address to the potential of juicy game design application in exergames. Understanding juicy game design and its functions in conjunction with the exergame environment will can perhaps add novel interventions and the creation of in-game visual design choices.

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[1]Beat Saber: https://www.beatsaber.com/

Chapter 3

Methodology

In earlier chapters, I outline the current applications and academic understanding of juicy game design. I also examine previous research on the understanding of what makes juicy game design effective and ineffective. The scope of research conducted for the purpose of this thesis centers around examining the perceived affect of juicy game design, rather than the direct experienced affect.

Measuring perceived affect differs from direct experience in that it requires the participants to use their imagination to fill in the blanks that exist in a prototype of the initial stage of a project. The benefits of this include the ability to gain an understanding of the impact that certain aspects of the technology have on the user without the resources needed to complete a full product. The limitations are that there may be a mismatch of presented mental models and expectations. This avenue of addressing the research questions was selected as a result of scope limitations due to the Covid-19 pandemic and restrictions around in-person research. In this chapter, I outline the design, methods, and processes used to collect, organize and analyze the data that is set to inform the rest of this thesis.

To reiterate, the questions outlined in Chapter 1 are as follows:

RQ1: How do various types of embellishments affect participants' perceived enjoyment of exercise media?

RQ2: How do embellishments affect participants' motivation to exercise?

RQ1 aims to provide understanding around the levels of enjoyment and positive affect felt by the user when being shown the three different conditions that will be further outlined in this chapter. This thesis will also examine potential reasoning as to why certain

conditions may be more enjoyable than others in various different contexts, and how this can inform future exergame and broader media design.

RQ2 examines a different aspect of juicy game design. The core motivation behind this research aside from gaining insight into more informed system design is creating more engaging and attractive long-term options for consistent exercise. Understanding how users react to different levels of embellishment and how those reactions shape their motivations and intentions is an important goal of this research. The data collected in the survey described below allows for an initial understanding of user exercise habit intentions. Findings from the former research question, RQ1, will also provide a glimpse of the rationale behind the motivation for player responses.

3.1   Survey Design

To create an accurate understanding of the questions looking to be addressed a combination of validated surveys and synthesized questions were used. When considering different validated scales for evaluating player experience, several different scales were examined including Stress Appraisal Measures [50], Positive and Negative Affect Scale PANAS [65], and the Player Experience Inventory (PXI) [1, 25, 62]. Each was considered based on how closely the questions in the scale matched the goals of RQ1 and RQ2, as well as their historical usage especially in previous related studies, and similar fields of research. Although applicability was the main factor, the length of the scale in average minutes to completion was also taken into account. Ultimately, the PANAS scale was selected as it was the best scale to give a direct measure of affect using tangible terms that users could relate to.

An exercise habit perception scale [23] was also used to give a basis for current exercise habits for each participant. The Godin Leisure-Time Exercise Questionnaire's [23] purpose is to provide a measurement of the users' levels of daily exercise by splitting types of exercise into three categories (mild, moderate, intense) and asking the user how many 15-minute time blocks are completed each. This allows the researcher to have a more thorough and accurate understanding of the participant's relationship with exercise and to what extent they currently exert themselves without taking intrusive data such as fitness and heart rate data.

It was equally as important to understand previous exposure to exergames as well as current exergame habits that the participants may have. Variances in responses and experiences may affect latter perceptions and are important to collect in order to further

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inform the research questions mentioned above. No formal collection methods were used, participants were given popular exergame titles and were asked to label whether or not they are familiar with the game. If yes, participants were asked how often they interact with the game - if at all. There was also an option to input their own games if there was one they have interacted with but was not mentioned.

For the final section of the survey, a comparison questionnaire between the three conditions was conducted. Questions relating to exercise perceptions for each of the conditions were input in this section to provide a direct understanding of the conditions and their perceived effect on exercise habit intentions.

3.2   Participants

Participants were recruited from Prolific[1] - a user recruitment platform with only one screening criterion requiring the users to have normal to corrected-to-normal vision as viewing the images was a key aspect of the study conducted. No further criteria were imposed as the intent of the research is to create an understanding of the effects that various levels of embellishments have on a diverse sample of participants. To account for differences in game and exercise preference and experience, the survey included questions that recorded information about the fitness and gaming knowledge of the participants. For this study, one hundred participants were recruited to complete the survey, with each being paid $6 CAD to participate. Of the participants recruited (N=100), five were excluded from the analysis due to failure to successfully complete attention check questions and an additional six participants were excluded because they did not complete the questionnaire properly resulting in a sample size of 89 participants (N=89). Participants averaged an age of 24, with a standard deviation (SD) of 6 and an age ranging from 18 to 66. Forty-eight of the participants identified as men, forty-six as women, and one participant identified as non-binary.

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[1]Prolific: Allows the researcher to quickly find participants which allows for rigorous checks and unbiased screening.

3.3   Materials

The survey study was constructed using Qualtrics[2] and distributed through Prolific. Visually reliant survey questions used the Graphics Interchange Format (GIF) to illustrate the three conditions with no additional stimuli provided. All conditions were displayed alongside the questions to ensure that participants did not need to rely on memory in order to respond.

3.3.1   Juiciness Levels

As there is little known about guidelines for creating different scales of visual juicy design, I conducted a scoping review to explore patterns in implementation. The main criteria I determined needed to be satisfied to be considered were the following. Juicy game design needed to be one of the considerations when creating conditions, and descriptions of visual embellishment levels must have been included as well.

I began the process by first searching titles, abstracts and full text in both the Association for Computing Machinery Digital Library (ACM) and Google Scholar using the keyword "Juicy Game". ACM yielded five results, of which two [27, 54] were included based on title and abstract screenings. Google Scholar yielded 81 search results using the same search parameters. 15 of the 81 works were identified as relevant through title and abstract screening, two of which were also found in the ACM search.

I then conducted a full-text screening in search of commentary on juicy level design within conducted studies. Six of the works were excluded due to ambiguity in how they determined juicy levels or no mention of juicy-related conditions. Another paper was excluded due to focusing solely on juicy audio effects without any change to the visual juicy design. The remaining eight papers were included in the analysis, although only three were displayed in a chart format due to the level of detail and relation to the research being conducted in this thesis. Table 3.1 shows the process of inclusion and exclusion of each paper.

When screening the full text of the included papers, I identified sections where the author's discussed their process of creating conditions with juicy game design. I then extracted the keywords used to describe the type of embellishment (ie. animations, particle effects) and compared the circumstances and magnitude of each implementation. These findings are discussed in detail below.

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[2]Qualtrics: Qualtrics is a powerful online survey tool that allows one to build surveys, distribute surveys and analyze responses.

Screening Step	Papers Considered
Relevant Papers	[47], [30], [71], [8], [33], [14], [12], [58], [21], [64], [56], [27], [28], [54], [35]
Papers Excluded due to no mention of creating various juicy levels, or no description of level features	[12], [71], [30], [64], [8], [47]
Papers Excluded due to a focus on audio with no visual elements	[56]
Included due to presence and descriptions of juicy levels, but only discussed in text due to either minimal details or distance in relation	[28], [21], [14], [58], [33]
Included in chart comparison	[27], [54], [35]

Table 3.1: A table detailing the flow of paper inclusions in the scoping review

In a paper on juicy design and gamification written by Hicks et al. [28], the juicy embellishments focus equally on audio and visual effects with the visual embellishments including animations and particle effects. These effects are triggered upon player gaze with the particle effects appearing initially and then occasionally. A similar visual effect is applied to a sight-reading training system created by Godfrey et al. [21] with blooming particle effects indicating hit or missed notes in the juicy condition. Similarly, Juul [33] briefly describes the juicy condition as including longer-lasting particle effects. All of these works had one set level of juicy design in which they all used particle effects with one study also having animated effects. Buckthal [14] uses primarily animations along with colour to differentiate between juicy and non-juicy conditions. These effects are active predominantly during user clicks, however they also appear during the game start and information screens.

The final work that was not included in the table was a thesis by Sung [58] where productive and unproductive friction is examined. Juicy game design is used as a tool for both productive and unproductive friction by using audio and visual embellishments. Although effect usage rationale was very detailed, the author created the unproductive condition to be deliberately difficult to use. As the intention is not to create high juicy conditions that are unusable this research was not included in the table below. Both productive and unproductive juicy conditions included explosions and screenshake upon user input. These conditions also included particle effects in the background and slight animations on the game screen. Sung [58] builds on these features in the unproductive condition by adding more particle effects and screen shake upon user input as well as some particle effects in the user foreground. There are also additional audio elements included to add to the chaos of the condition.

When determining the three levels of juiciness (low, medium, high) to be used in the study, in addition to works mentioned above, studies exploring visual juiciness levels [27, 35, 54] were used to create initial juicy level guideline and stimuli. They were then presented to the original game developers to ensure the integrity of the core concept of the original game was present in the study materials. To summarize the different design choices made in regard to the juicy levels in the papers mentioned above, as seen in Table 3.2, Table 3.3, and Table 3.4. Although the motivations behind the research were different, all authors use the concept of juicy game design as well as distinct levels with visual differences.

Kao's research[35], focuses on the user experience within distinct visual levels in a role-playing game. Within the developed stimuli, Kao also uses audio as another level of juiciness that is not examined in this table. This creates another dimension of juicy game design that adds to game perception and should be kept in mind when reviewing the differences between visual juicy design levels.

When creating the games for their study, Hicks [27] focused on creating polished games that look ready for release with one version being referred to as standard and another as juicy rather than low and high. The reason for the high level of polish in both was to ensure that the differences in experience would be attributed nearly entirely to the embellishments added, rather than one game condition feeling like it was incomplete or still in development. When discussing successful validation, the author referred to the conditions as juicy being "perceived as containing suitable juicy elements" and the standard versions "perceived as not containing comparable juicy elements (but could still be considered finished and polished games)" [27]. Although, if levels had to be assigned, based on other works [35, 54] it would likely be categorized as standard having medium juicy elements and the juicy condition having high juicy elements.

Research on juicy haptics [54] also used visual embellishments as a visual match for their designed haptic embellishments. Where visual embellishments were involved, the study contained only two levels of visual juicy game design categorized as low and high. In this study design, visual embellishments were not the main point of interest however there was still a lot of thought put into how visual juicy game design was implemented. As with the studies mentioned above, it is important to understand the role of visual embellishments within the research. They may play a different role when they are not the only stimuli present, thus resulting in potentially skewed visual juicy level thresholds.

Some evident trends that are present in synthesized level creation [27, 35, 54] include screen shake increase in high levels of juicy effects, increases in the size and spread of particle effects, and more dynamic animations.

Based on the structure and design choices of visual juicy design level separation in the previous works [27, 35, 54], a strategy was created to ensure the creation of the separate conditions for the survey study would be logical. The game elements were sectioned off into four areas: the UI (four corners), hit/miss indicators, gameplay, and game background. They were then individually edited to match the three predetermined levels of juiciness.

As the definition of juiciness requires all embellishments to be non-integral to gameplay and completion, the different aspects that changed within the games were purely aesthetic. The low juicy level is characteristically defined by simplistic UI (only information no icons, square shape, only text), with minimal use of visual elements such as icons. There are virtually no particle effects and less vibrant to the overall design.

Medium juiciness steps up the visual effects by adding some UI embellishments through the shapes and coloured outlines along with various icons. There are some background textures through static elements and some particle effects. The colour level matches that

Visual Elements	The effects of juiciness in an action RPG [35]	Juicy Haptic Design: Vibrotactile Embellishments Can Improve Player Experience in Games [54]	Juicy Game Design: Understanding the Impact of Visual Embellishments on Player Experience [27]
Levels of Juicy Design	❯ *None*, ❯ *Medium*, ❯ *High*, ❯ *Extreme*	❯ *Low*, ❯ *High*	❯ *Standard*, ❯ *Juicy*
Colour	Colour was consistent throughout all conditions	❯ *Low:* No colour was used. Game entirely in black and white ❯ *High:* High contrast colours	The same colours were used for both conditions.
Animation	Same character movement animation was used for all conditions. ❯ *None:* Abilities have a narrow, short duration animation. ❯ *Medium:* Abilities have slightly less narrow animation that enlarges and lasts longer. ❯ *High:* Animated flame and/or smoke tower upon impact is added. ❯ *Extreme:* In all abilities, the size of animation takes up the entire screen. In some abilities, lightning strikes are added in addition to smoke and flames on impact. Lasts a significant amount of time.	❯ *Low:* No animation besides what was necessary ❯ *High:* Ball squishes and stretches upon impact, the bricks will also fall, shrinks, and fade out on collision. On collision with the ball, the paddle wobbles back and forth	❯ *Standard:* **Cuber:** No animation besides what was necessary. **Dungeon Descent:** Motion from weapon movement shown. Enemies break apart once slain. **Quake 3 Arena:** Typical First Person Shooter(FPS) animated features. ❯ *Juicy:* **Cuber:** The cube rotates in the direction it moves. All objects on the game screen also bounce and pulsate in the rhythm of the game music. Upon player collision, the cube flies off the screen. **Dungeon Descent:** The UI, player weapons and hits on an enemy all have additional animation effects. **Quake 3 Arena:** 3D object animations, and emphasized gore animation.

Table 3.2: A summarized list of the colour and animation juicy level features listed in each research paper that has previously studied juicy visual design

Visual Elements	The effects of juiciness in an action RPG[35]	Juicy Haptic Design: Vibrotactile Embellishments Can Improve Player Experience in Games[54]	Juicy Game Design: Understanding the Impact of Visual Embellishments on Player Experience[27]
Particle Effects	❯ *None:* Most magic abilities only feature a few particle effects on impact. One magic ability shows a larger size and quantity of particles upon impact. ❯ *Medium:* Continue to explode after impact for roughly half a second. They include fire as well as smoke. ❯ *High:* Visible upon casting and increase upon impact. Leftover effects last longer once the spell is complete. ❯ *Extreme:* In some abilities, effects upon casting and impact take up a large portion of the screen and are active long after the spell has impacted the target.	❯ *Low:* No particle effects were used. ❯ *High:* Particle effects were used when the ball spawned as well as when it collided with objects	❯ *Standard:* **Cuber:** No particle effects.. **Dungeon Descent:** No particle effects. **Quake 3 Arena:** Some particle effects upon shooting. ❯ *Juicy:* **Cuber:** Shown as colourful trails behind the cube and upon completion of the level. **Dungeon Descent:** Shown upon enemy hits and deaths, player movements such as dashes, and level changes. **Quake 3 Arena:** Many blood and gore-related effects are added upon successful hits and enemy deaths.
User Interface	Although some visual UI changes were mentioned on clicking and hovering of menu buttons, they were not available for viewing in the research paper.	There were no separate menu screens or user interface elements outside of the direct gameplay presented.	**Cuber & Quake 3 Arena:** No significant UI changes were implemented into the conditions. ❯ *Standard:* **Dungeon Descent:** UI Elements are static on the screen ❯ *Juicy:* **Dungeon Descent:** UI elements shake along with player action and pulse with achieved milestones.

Table 3.3: A summarized list of the particle effect and user interface juicy level features listed in each research paper that has previously studied juicy visual design

Visual Elements	The effects of juiciness in an action RPG[35]	Juicy Haptic Design: Vibrotactile Embellishments Can Improve Player Experience in Games[54]	Juicy Game Design: Understanding the Impact of Visual Embellishments on Player Experience[27]
Screen Shake	*None:* No screen shake. *Medium:* No screen shake on all magic abilities but one, which had barely noticeable shake. *High:* No noticeable screen shake on most magic spells but one, in which the screen wobbles several times before settling after impact. *Extreme:* Evident screen shake in all magical abilities, at times heavily obscuring game screen and vision.	*Low:* No screen shake was used. *High:* Screen shake upon object collision.	**Quake 3 Arena:** No screen shake was used for either condition. *Standard:* **Cuber:** No screen shake was used. **Dungeon Descent:** No screen shake was used. *Juicy:* **Cuber:** Screen shake was used upon cube movement. **Dungeon Descent:** Screen shakes when enemies create an impact on the ground as well as during successful player hits, or when taking damage.

Table 3.4: A summarized list of the screen shake juicy level feature listed in each research paper that has previously studied juicy visual design

of the full juicy version. Full juicy design in the context of this study will include fully embellished user interfaces that pulse and react along with the user's progress, full particle effects will also play a role in providing feedback to users' movements. The background has many dimensions and moves along with the player interactions.

For the purpose of the survey, three different GIFs were created to showcase each of the three conditions. The creation of the GIFs was separated into three different phases. The first included the sectioning of the user interface of the base game Sphery Racer as described above. The different clusters of UI elements were grouped based on the function that the feature would provide in its natural, un-embellished state. The groupings were titled as such: progression UI, success measure, instructional elements, and background. Each of these categories has varying levels of juicy game design application, which were recorded in detail along with the specific feature they were tied to. Each of these elements was then reduced to a bare minimum functioning version with no visual embellishment. This became the first condition that showcased a less juicy version of the base game Sphery Racer- which acted as the full juicy, or release game condition. The medium juicy condition was created by adding a visual average of the two conditions together. This was done by removing most particle effects and robust graphical elements such as visual screen jitter. Simplistic icons and bursts of colour were also applied to the medium version to add some visual interest to the condition.

The second design phase involved informally showcasing each of the designs to other researchers as well as Exercube team members to gain an understanding of the playability of each version and integrity in relation to the originally released game.

The primary concern with the first version particularly the low juicy version was the inability to properly receive cues for the exercise actions due to not having enough visual

information. As a result, movement lines and the original in-game track were restored to the game, and a cue, in the shape of a line, for when each action should be performed was added to aid the user in timing their movements appropriately. The second main concern was not about the conditions themselves, but rather the construction of the GIFs.

With permission from Sphery LTD, each of the GIFs was created based on a video of exercube gameplay taken from the Sphery website. To ensure that each GIF was the same in length, elements and general content, the original video was saved and imported into *Adobe Photoshop*[3] where it was reviewed frame by frame for key in-game moments. These include, the display of the action/player instruction, prompts to complete the action, completing the action, and action/score achievement. Each of the selected keyframes was selected for an initial number of 14 frames derived from the initial video. Once this stage was complete, the file was duplicated two times for a total of three separate copies, each of which was then edited in *Adobe Photoshop*, frame by frame according to the guidelines outlined below. Each frame was 0.25 seconds in length with the GIF looping indefinitely. Although for the purposes of showcasing the quality of each condition the 14 frames more than sufficed, the concern of those reviewing the conditions was that the final GIFs being shown were too choppy and disjointed to seem like a functioning game and therefore would not provide enough immersion to those completing the survey. This was amended by returning to the original content source and selecting additional frames in between the key content frames to create more smoothness in the movement of the GIFs.

In the final design phase, the changes listed above were implemented to create the list shown below, along with the addition of extra frames, raising the total number to 42. The next section covers a summary of the UI qualities and embellishments or lack thereof of each condition along with a screenshot of the GIF used in the final survey.

3.3.2 Conditions

Condition 1, labelled as Low Juicy, was created to have minimal colouring and an extremely simple user interface. The main goal of this condition was to ensure easy access and understanding of the exercises to be completed without the chaos of visual distractions. No embellishments in a role-playing game environment have been studied and shown to significantly decrease player experience, motivation and performance [35]. The goals of exercise games and role-playing games are different, therefore this condition mimics exercise that may be performed in a gym environment where no embellishments or juicy design may be found to be beneficial. Along with the simple UI displaying information in a

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[3]Adobe Photoshop: https://www.adobe.com/ca/products/photoshop.html

minimalist format, there are no additional icons to be used as indicators. For example, upon completing a movement, instead of stars, fractions will appear indicating how well the player performed. There is also a reduction of camera shake, particle effects and colour. The game background has no graphical features and action instructions are shown with minimalist graphics.

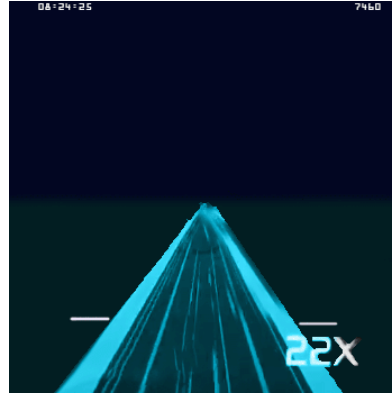
Figure 3.1: Instructions for low juicy condition

Figure 3.2: Timing depiction of low juicy condition

Figure 3.3: Performance score of low juicy condition

Condition 2, labelled Medium Juicy creates a middle ground between the low and high conditions. It begins to introduce a visual story element through graphics and includes more icons, colour and graphical movement. It does not include particle effects and highly graphical elements. The UI elements that were designed to be minimalist in the Low Juicy condition, now have a shape to them as well as colour. There is also an introduction to using simple motivating icons such as stars and hoops for the players to use as action indicators. Condition 3, is labelled as the High Juicy version is the original version of the released game on which the other two conditions were based upon. This condition has UI element jitter as well as refined display aesthetic. It also contains particle effects and additional graphics upon player action and completion. The score shows up a glowing and moving star scale that pulses as it notifies the user of their success. The background graphics are also more defined and create a detailed environment in which the player is immersed.

Figure 3.4: Instructional depiction of medium juicy level condition

Figure 3.5: Timing depiction of medium juicy level condition

Figure 3.6: Performance indicator of medium juicy level condition
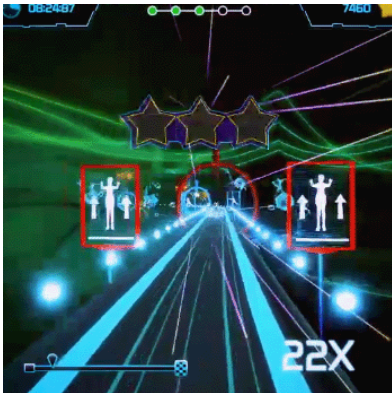

Figure 3.7: Instructional depiction of medium juicy level condition

Figure 3.8: Timing depiction of medium juicy level condition

Figure 3.9: Performance indicator of medium juicy level condition

3.4   Procedure

We used Prolific to recruit. We informed the participants about the motivation, purpose, and goals of the study. They are then given a consent form outlining the data being collected as well as their rights as participants to withdraw without penalty. The participants are then asked to disclose and self-describe their gender identity as well as age. They then provided an account of their average exercise habits. This part of the questionnaire is split

into several categories to create a thorough understanding of the participants' relationship with exercise.

The first section is a validated questionnaire [22] designed by Godin to capture the exercise levels of the participants. The survey asks participants to consider a seven-day period and describe how many times they do different exercise levels. The quantity of exercise is measured as the number of fifteen-minute sessions within seven days, and exercises are broken down into three types (strenuous, moderate, and mild) with examples of activities that closely resemble those performed in each type. We calculated the results to produce an interpretation of the participants' levels of activity within their lifestyles. Following the Godin Leisure-Time Exercise Questionnaire [22], participants are asked to rate their enjoyment of various levels of exercise on a five-point Likert scale, and indicate their primary modalities of exercise (gym, organized classes, sports, etc.). The next set of questions relates to the participants' exposure and knowledge of existing exergames as well as the frequency at which people play them. This was included to ensure that different levels of understanding of exergames are accounted for in the data and analysis of this study.

At this point in the survey, the participants received a notice on their screens introducing the animated conditions and reinforcing the purpose of the following sections. As the animations were constructed from individually edited frames it was important to remind participants that the features of each image is the focus of the study, rather than the smoothness and quality of the graphics.

Following the notice, participants completed the PANAS [65] questionnaire for each of the three conditions in a randomized order. Each condition is on a separate page of the survey with an image of the condition on every corresponding page. Throughout each PANAS questionnaire, there are also attention check questions placed randomly among statements.

Once all three questionnaires are complete, the survey moves on to a comparison questionnaire with six sets of two conditions at a time. The comparisons are as follows, with each appearing twice:

1. High and Medium

2. High and Low

3. Medium and Low

The reason they are presented separately is to understand preference at a base emotional level, separately from questions related to preferences such as "working out more".

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These sets of questions ask the participants about various levels of emotional preferences as well as how they may affect fitness habits. The subject of the questioning follows a similar model as the PANAS , however, it differs in that it presents each of the conditions side by side with the intent of creating a preference measure through informed choice. Below is a list of questions as presented in the survey:

1. "Look at the interfaces one at a time, which interface would you find more:"

   (a) "Enjoyable"
   (b) "Boring"
   (c) "Engaging"
   (d) "Motivating"
   (e) "Mentally Taxing (I find this tiring to focus on)"
   (f) "Overwhelming"
   (g) "Confusing"

2. "Look at the interfaces one at a time, which interface would encourage you to:"

   (a) "Work out more frequently"
   (b) "Work out during longer sessions"

Attention check questions are also present throughout this section of the survey to ensure that participants are attentive throughout the entirety of the questioning. The final step gives participants the option to provide comments on each of the interfaces if they wish. This was included as a source of additional qualitative information but was not mandatory to complete as it was not intended to be used in any thematic analysis. It may be used to inform some feature research as well as give participants an opportunity to reflect on the different interfaces within their own chosen contexts. Out of N = 89 participants, 53 left comments about how each of the conditions affected them and the thoughts they had throughout the survey.

After the final step of the survey, the participant is thanked for their time and reminded of the study details as well as their privacy rights, the full extent of the anonymous data collection, and their overall contribution to the research. They are then redirected to a screen linked to Prolific that informs the researcher that the survey has been completed. Once this notification has been received the participants are remunerated within a business day of the survey completion. This study received ethics clearance through the University of Waterloo Research Ethics Board (REB[43840]) prior to the administration of the survey.

3.5   Analysis

The analysis for this study begins with the export of raw data from Qualtrics into a CSV format where it may be cleaned up and set up for further analysis. The initial cleanup was completed in Excel, with certain columns that are irrelevant to the analysis removed. This includes columns with the date, unique response id, input language, consent status (once it was established that consent was given), and progress percentage on the survey. Following the removal of the listed columns, the data were screened for failed attention check completion. There were a total of twelve attention check questions split between the various sections of the survey. The distribution was as follows, three within the PANAS Medium condition, as well as the PANAS High condition, two within the PANAS Low condition, and four in the condition comparison question section of the survey.

Out of the one hundred participants, five were excluded due to failure to successfully complete one or more attention check questions, the data of these participants was marked and cleared from the overall data corpus. Once removed, the rest of the working data was split into two main categories of analysis.

3.5.1   PANAS - The Positive and Negative Affect Schedule Analysis

The PANAS questionnaire took up one central part of the analysis, and the condition comparisons made up the second portion of the analysis. The data from the PANAS section of the survey was separated into a separate sheet and converted into a more convenient format for analysis by transforming the written 5-point Likert scale options to numerical values. Through the process of cleaning the data, an error in the technical survey design was found which led to several of the score responses not being recorded. As mentioned above, five were excluded from the analysis due to failure to successfully complete attention check questions and an additional six participants were excluded because they did not complete the questionnaire properly resulting in a sample of size of 89 participants included in the full analysis.

- Very slightly or not at all, transformed to 1

- A little, transformed to 2

- Moderately, transformed to 3

- Quite a bit, transformed to 4

- Extremely, transformed to 5

The data was then imported into *Jamovi*[4] to assess the PANAS and comparison studies for assumptions of normality by applying the Shapiro-Wilk test (N=89). All conditions had a p below 0.05, indicating that the data is not normally distributed. Thus, Friedman tests were used for the rest of the data.

The Positive and Negative Affect Schedule is a scale designed to measure the overall emotional impact a certain experience has on a user. The scale was developed in the 80s by three psychology researchers looking to find a way to separately capture positive and negative moods to create a more precise depiction of emotional experience [65]. In the context of this scale, as well as the research presented in this thesis, "Positive Affect (PA) reflects the extent to which a person feels enthusiastic, active and alert" [65], while Negative Affect (NA) represents "a general dimension of subjective distress and unpleasurable engagement that subsumes a variety of aversive moods and states, including anger, contempt, disgust, guilt, fear and nervousness" [65].

Having a high positive affect score indicates a "state of high energy, full concentration and pleasurable engagement" [65]. A low negative affect score indicates "a state of calmness and serenity" [65], and so it can be seen that the results in receiving a positive score for either of the scales (low negative affect or high positive affect) is prompted by different player emotion, thus justifying the separation of the two in analysis.

The PANAS scale has proven to be appropriate to use in areas of research that rely on accurately capturing dimensions of user mood while engaging with a stimulant. In this case, the three conditions (Low juicy, Medium juicy, and High juicy) were presented to the survey recipients in a randomized order following the PANAS questionnaire format. The participants of the survey were also primed to complete the survey with a message describing how the images were created, and the focus of the survey to ensure that their responses were accurate to the nature of the research.

When examining the scoring of the PANAS model, it should be noted that in the context of exercise games a high positive affect score would be rated as more important than achieving a low negative affect score. To reiterate what was noted above, the positive affect scale has excitement, concentration and pleasurable engagement on the high-ranking side, and sadness as well as lethargy on the low-ranking end of the scale. This is contrasted with negative affect which on the low end of the scale indicates a state of calmness and serenity, while the high-ranking end indicates distress such as fear or nervousness. As the

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[4]Jamovi: Statistical software

goal of exergames centres around creating active engagement, alertness and energy, on the PANAS value scale high PA is a more desirable end result over low NA.

3.5.2 Comparison Data Analysis

The following portion of the survey asked the participant to respond to prompts, and thus the resulting data appears in the form of user choices of either "interface 1", "interface 2", or "neither/both". The comparisons were analyzed by first separating the different keywords to the questions into two categories: positive, and negative. The positive keywords/phrases were as follows: "Enjoyable", "Engaging", "Motivating", and "Work out more frequently". The rest were sorted into the negative category: "Boring", "Mentally Taxing (I find this tiring to focus on)", "Overwhelming", and "Confusing".

The comparison study was analyzed in a similar manner as PANAS . As stated above, to ensure consistency the 11 participants removed in the PANAS section of the survey were also excluded in the comparison portion of the survey analysis.

The overall results were then calculated by condition, giving 1 point to each time a participant chose each condition over another for a positive context, and subtracting 1 point every time a condition was chosen over another in a negative context. For the choice of "neither/both equally", no additional points were given, nor subtracted.

These scores were then added up for a negative, and positive score for each of the conditions, as well as a total score. When added together this results in the highest score of 8 and the lowest possible score being -8. The total score data was imported into Jamovi for analysis and was assessed for normality using the Shapiro-Wilk test. Further analysis was conducted using Friedman test and pairwise comparisons.

3.6 Summary

A survey study was conducted with the purpose of gaining a greater understanding of how users from various backgrounds perceive various levels of juicy design within the Sphery Racer *Sphery Racer* exergame . Using a validated scale of affect, combined with a comparison scheme tailored to the research questions of this thesis, quantitative data was collected and analyzed. The results of the analysis will be discussed in the following chapters, along with their implications and opportunities for the next steps.

Chapter 4

Results

4.1 PANAS Results

The Positive and Negative Affect Scale results indicate that overall all of the conditions were not found to be distressing, or not pleasurable for the participants. A non-parametric Friedman test among repeated measures was conducted on the Negative Affect results and yielded a Chi-square result of 8.3, $df = 2$, which was significant ($p < .016$). A pairwise comparison (Durbin-Conover) also shows significance ($p < .004$) between the negative affect of Low and Medium condition scores as seen in Table 4.1.

	Statistic	p
NA-Low - NA-Med	2.93	0.004*
NA-Low - NA-High	1.53	0.128
NA-Med - NA-High	1.40	0.162

Table 4.1: Table of Negative Affect Pairwise Comparisons (Durbin-Conover)

The means of the Low juiciness condition were significantly lower in negative affect than the Medium juiciness condition with thier scores equalling to 13.6 ($SD = 5.14$), and 14.3($SD = 4.55$) respectively (Figure 4.1). However, no effect was found between Medium and High condition scores ($p = .162$), nor between Low and High ($p = .128$), as seen in Table 4.2.

In the scoring documentation provided by the authors of the PANAS [65], the mean negative affect score is shown to be 17.4 ($df = 2$), ($SD = 6.2$) which indicates all conditions

	NA-Low	NA-Med	NA-High	PA-Low	PA-Med	PA-High
N	89	89	89	89	89	89
Missing	0	0	0	0	0	0
Mean	13.6	14.3	14.2	15.7	23.2	23.2
Median	11	13	12	13	24	24
SD	5.14	4.55	5.23	6.96	8.13	8.26
Minimum	10	10	10	10	10	10
Maximum	32	32	32	37	38	39
SW-W	0.729	0.830	0.760	0.793	0.956	0.950
SW-p	<.001*	<.001*	<.001*	<.001*	<.004*	<.002*

Table 4.2: Table of PANAS Result Descriptives

have received a lower-than-average scoring. Although significantly higher than the Low juicy conditions, the High condition is lower than the mean provided.

In contrast with the negative affect results, the results of the positive affect regarding the condition paint a different image. The mean level of Positive Affect that was provided as a guideline is 33.3 ($SD = 7.2$). The low juicy condition scored a near minimal score at 15.7 ($SD = 6.96$) and was only 5 points above 10 - the lowest possible score on the PANAS scale.

Both Medium and High juicy conditions scored significantly higher than the Low condition, although with means that are 23.2 ($SD = 8.13$) and 23.2 ($SD = 8.26$) respectively they are still below the mean positive scoring (Figure 4.2). A non-parametric Friedman test was once again applied among repeated measures. Results of the Positive Affect data yielded a Chi-square result of 75.7 which was significant ($p < .001$). The pairwise comparisons between the positive affect low and positive affect medium condition also showed significance ($p <= .001$), along with positive affect low and high conditions ($p <= .001$), as seen in Table 4.3

	Statistic	p
PA-Low - PA-Med	9.954	<0.001*
PA-Low - PA-High	9.801	<0.001*
PA-Med - PA-High	0.153	0.878

Table 4.3: Table of Positive Affect Pairwise Comparisons (Durbin-Conover)
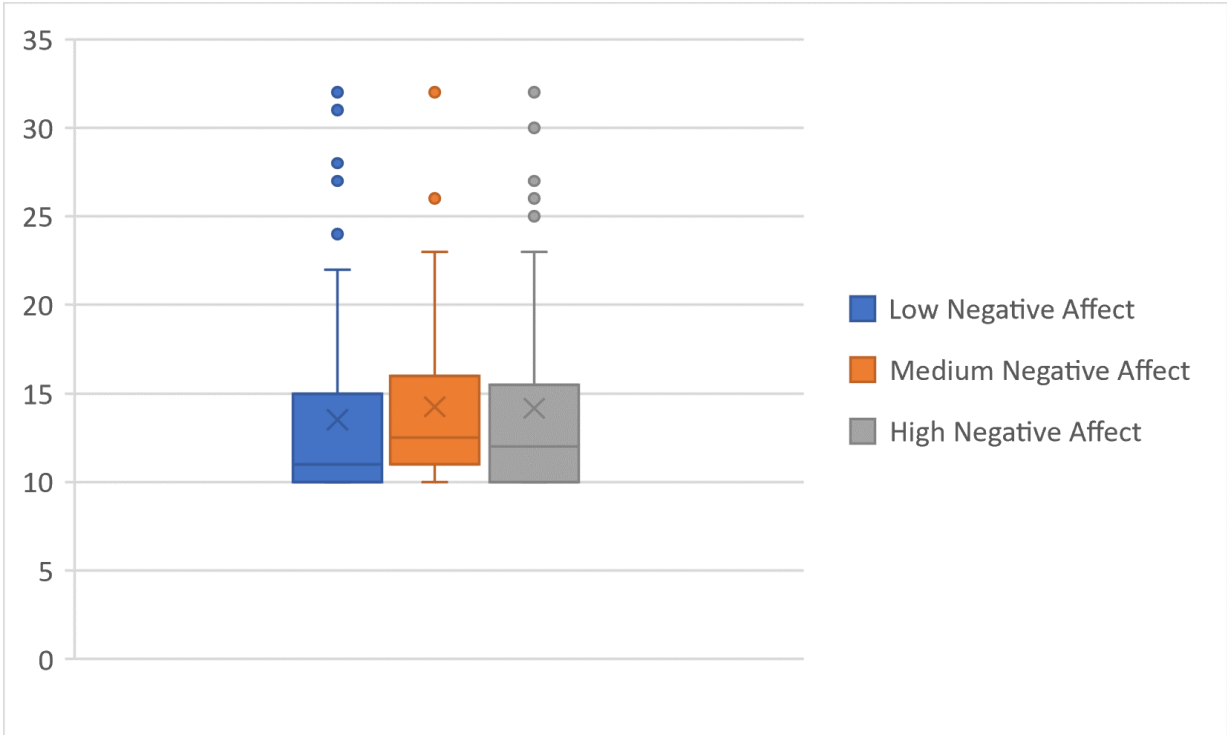
Figure 4.1: PANAS Negative Affect Results
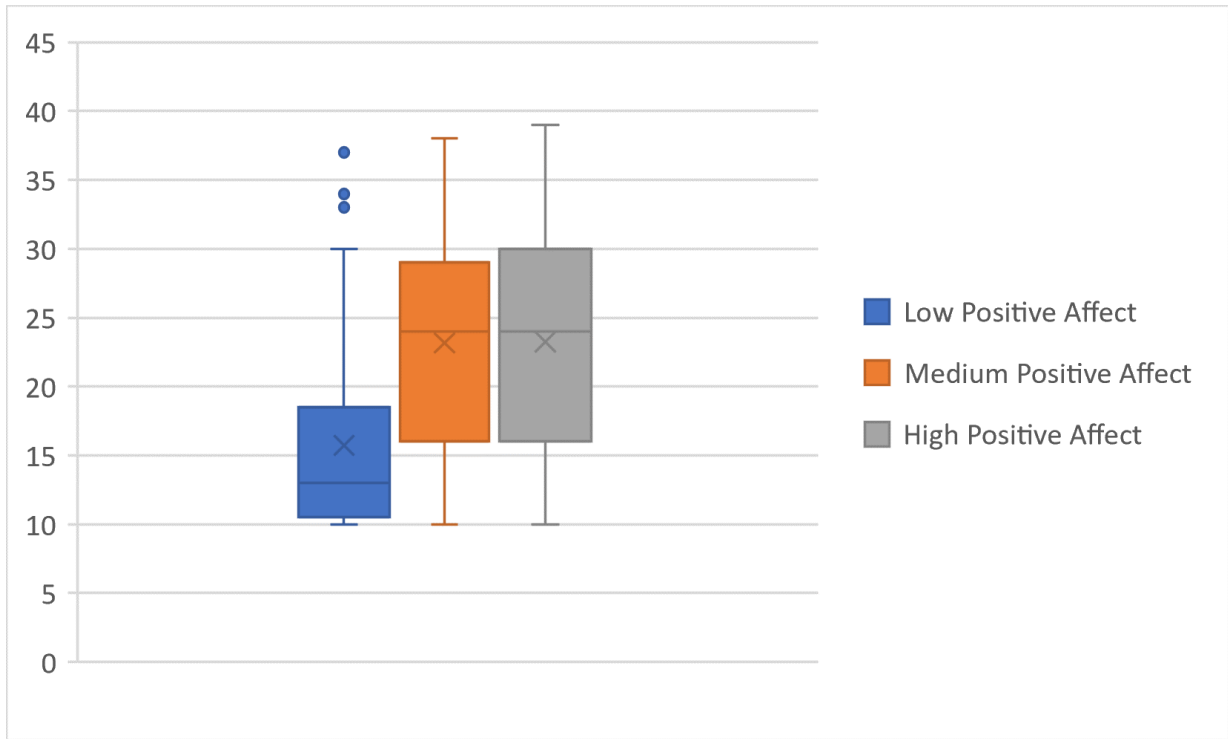
Figure 4.2: PANAS Positive Affect Results

4.2   Comparison Survey Results

The goal of the comparison study was to understand the participant's preference when examining the different conditions side by side. The data was assessed for normality using the Shapiro-Wilk test ($n = 89$). The test showed a p-value of .008 for the Medium condition and $< .001$ for Low and High as seen in Table 4.4. Thus, further analysis was conducted using a non-parametric Friedman test among repeated measures and rendered a Chi-square value of 16.1 which was significant ($p < .001$).

The pairwise comparison showed significance in results between the high-medium and low-medium conditions, both of which have a p-value of $< .001$. This shows that the Medium Juice condition was selected over both the Low and High Juice conditions fairly consistently, but the same cannot be said between the High and Low conditions.

As evidence from previous work suggests in previous research, no embellishments and juicy effects may result in an overall dull experience that decreases enjoyment and player motivation. Participants rated the low condition consistently more boring than the other

	Total-High	Total-Med	Total-Low
N	89	89	89
Missing	0	0	0
Mean	0.944	2.03	0.899
Median	1	2	1
Standard Deviation	1.75	2.64	2.44
Minimum	-4	-6	-7
Maximum	4	8	10
Shapiro-Wilk W	0.928	0.957	0.940
Shapiro-Wilk p	<.001*	0.005*	<.001*

Table 4.4: Table of Comparison Survey Result Descriptives

	Statistic	**p**
Total-High - Total-Med	3.395	<.001
Total-High - Total-Low	0.414	0.679
Total-Med - Total-Low	3.809	<.001

Table 4.5: Table of Comparison Survey Pairwise Results (Durbin-Conover)

two conditions, this is fairly unsurprising as the results of the PANAS showed similar conclusions through a low positive and negative affect scoring.

Where enjoyment, motivation and engagement were concerned, more juicy features were on average better than none at all (see Figure 4.3, Figure 4.4, Figure 4.5). When comparing the High and Medium conditions, however, medium juiciness was on average more preferred than high juiciness while also being slightly more mentally taxing and overwhelming. Perhaps this can be attributed to a preference in the display of information and level of embellishments present, however, these results are somewhat mirrored in the results of the PANAS as well. In both negative and positive affect, the Medium and High conditions were rated quite similarly with the Medium condition having a slightly higher negative affect rating indicating a higher level of distress in the forms of fear and nervousness.

When examining the High and Medium comparison charts (see Figure 4.3, Figure 4.4, Figure 4.5) it can be seen that when choosing between the High and Medium conditions, a lot more participants selected the Neither/Both options than in any other condition match up. This is an interesting result, that further indicates that a little juicy design goes a long way.
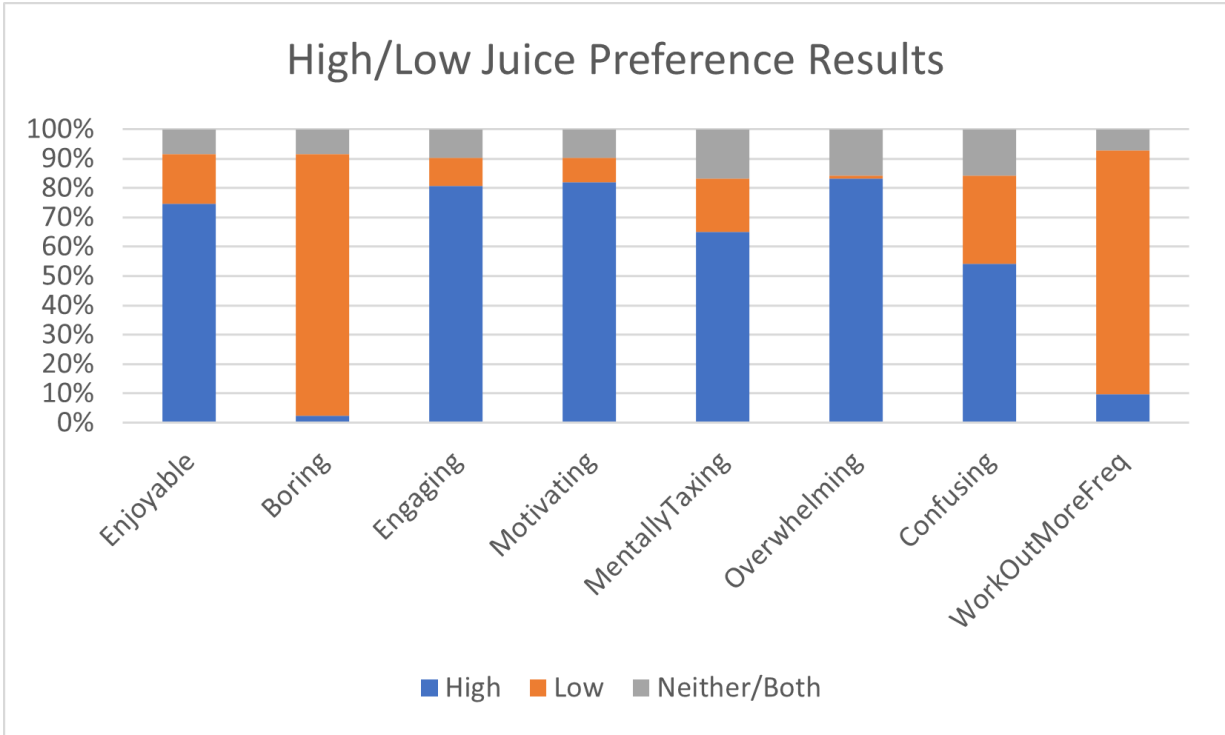
Figure 4.3: Comparison preference results between High and Low conditions
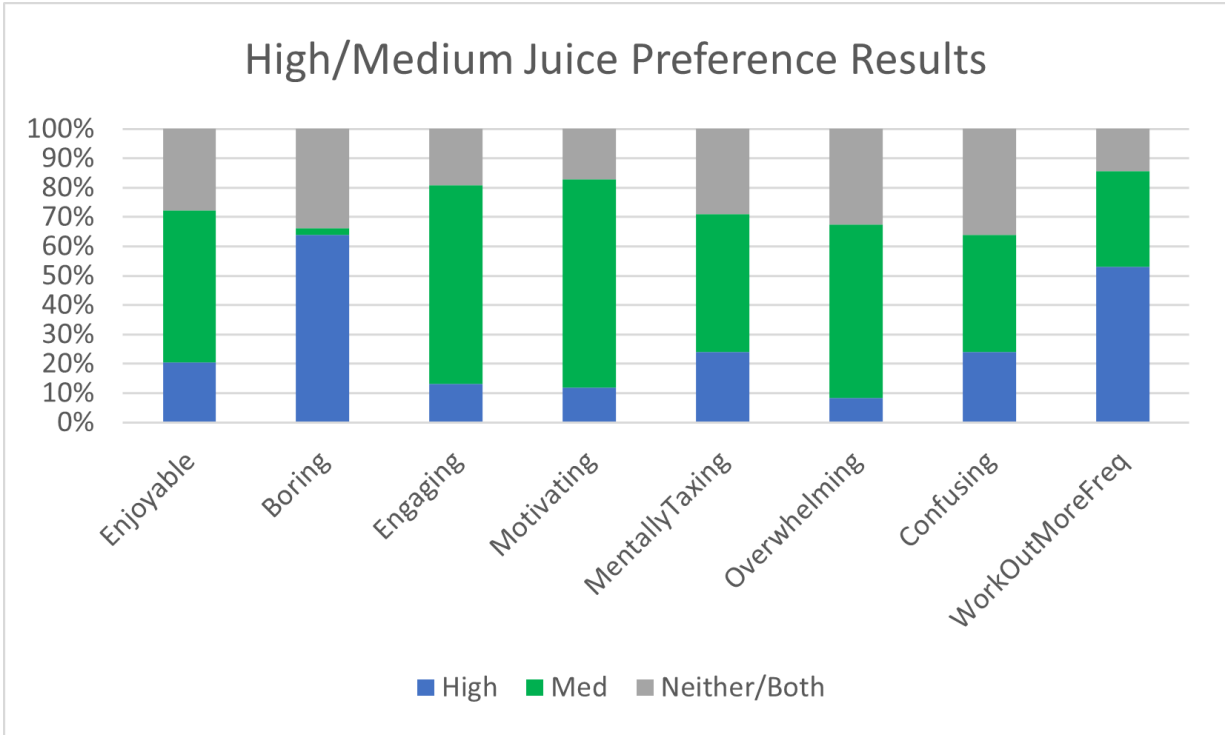
Figure 4.4: Comparison preference results between High and Med conditions
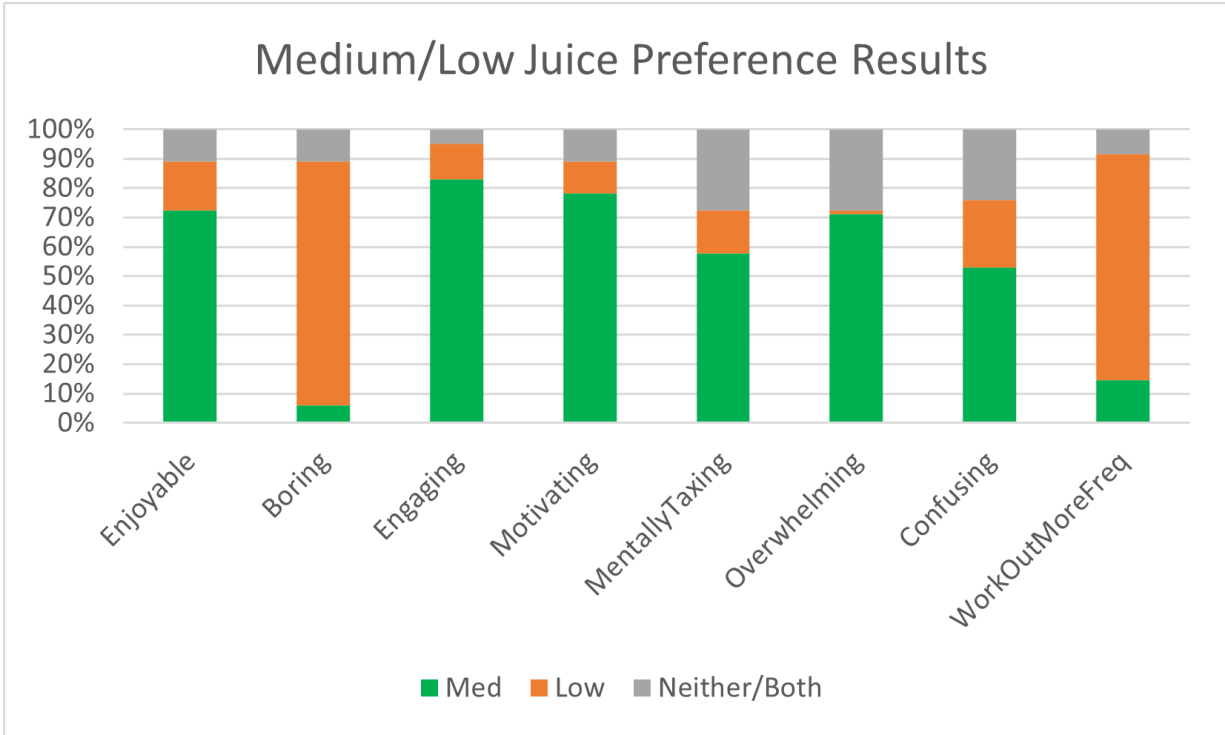
Figure 4.5: Comparison preference results between Low and Med conditions

Chapter 5

Discussion

The amount of embellishments used in an application has the potential to influence much of the user experience of a game application [4, 27, 54]. Using just the right amount of embellishments at the right moment can have monumental and cathartic effects, while neglecting to use any or using too much may result in a subpar and in some cases negative experience [35].

Through a survey study, three distinct levels of juicy game design were examined. Resulting data were analyzed through which two main validations of previous research were revealed:

1. Even low levels of juicy game design have a large impact on the perception of the game.

2. Embellishments may create feelings of stress in players and as a result, sometimes a large number of embellishments may have adverse effects and decrease user experience.

Additionally, data yielded a finding that suggests lower levels of embellishments may create better atmospheres for exergame and digital workout applications. This section will discuss the potential applications, and implications of the findings, as well as go over the limitations and future work.

5.1 Juicy Influence

Effectively adding Juicy game elements creates a larger aesthetic appeal in games and creates a larger impression of player actions. Through this players also experience more

meaning and immersion in the games they are playing [27, 56]. In the following subsections, I will go into detail on how the results translate to player impressions, preferences, and what this implies for future exergame design.

5.1.1   Positive and Negative Affect Schedule (PANAS) Discussion

When examining the negative affect results of the PANAS, it was observed that the Low condition had a significantly lower score than the Medium condition. This can likely be attributed to the visual simplicity of the Low juicy condition. As stated by Watson, Clark and Tellegan [65], low negative affect translates to evoked feelings of "calmness and serenity", and perhaps extends to feelings of aloofness and indifference in the context of the media. The overall negative affect results of all three conditions showed lower scores than the baseline provided by the developers of the PANAS [65].

The positive affect results for the Low condition were close to the lowest positive affect score possible within the scale. This may be attributed to the participants having feelings of sadness and lethargy towards the media examples that were shown throughout the survey. The results for the Low juicy condition in the positive affect scale agree with those presented in the negative affect scale. Although at first glance they appear contradictory, they both indicate disinterest to the point of indifference and boredom.

Although when compared to the mean, positive affect scoring indicated in the PANAS guidelines [65] of 33.3 (SD±7.2), both the Medium and High conditions scored quite low with means of 23.2 (SD±8.13) and 23.2 (SD±8.26) respectively. However, they still scored significantly higher than the Low condition (15.7 (SD±6.96)).

The overall lower scores may be attributed to the medium through which the conditions were presented. It makes sense that the Medium and High scores remain significantly higher than that of the Low juicy condition. Compared to no embellishments or juicy elements at all, any amount of graphic enhancement through effects provides a drastically different emotional response as shown by the results presented.

When considering these results in relation to each other, one can see that for overall experience, adding juicy effects, specifically visual embellishments has a positive influence on player experience. Looking at the positive affect results, the significance shown in the pairwise comparison (Table 4.3) between the Low and Medium conditions as well as the Low and High conditions indicates that the addition of visual embellishments creates more energy and enthusiasm in participants. Even the slight addition of some minor effects was enough to create a higher positive affect than the Low condition which contained none. It is interesting that through the PANAS scoring, positive affect between Medium and High

conditions remained fairly similar even though there is a significant step up in terms of the embellishments present. This could indicate that beyond a certain threshold of graphics and embellishments, there is no longer any addition to positive affect.

In the results of the negative affect data, significance was found between the negative affect results of Low and Medium conditions, but not between Low and any other condition. At first glance, this may appear counter-intuitive, as both Medium and High conditions had better positive affect scores than the Low condition. Given negative affect allows insight into the amount of distress that a player is under, a low score in the Low juicy condition may not appear for the same reason there is a low score in the High Juicy condition. Seeing low negative affect in the High juicy condition may be attributed to several different factors such as additional graphics and effects that convey positive reinforcement reducing the feeling of stress and confusion. Although this result contradicts some existing research in Juicy game design that has shown, often with the addition of juicy effects, more room exists for players to feel overwhelmed and uncomfortable [35]. As the study was not conducted using an Exercube, instead relying on digital imagery, it is also likely all scores were skewed downward to account for the lack of physical activity that would normally accompany the presented images.

5.1.2   Juicy Design Comparison Discussion

The comparison results show clear preferences towards both the High and Medium Juicy conditions within most of the keywords, however in some cases the Low condition had advantageous scoring. Surprisingly, the Low condition outperformed other conditions when prompting participants to answer which conditions would motivate them to work out more frequently. Perhaps this can be attributed to the simplicity and lack of overwhelming features, and personal preferences.

Although the condition was widely rated as more boring than the others, it provided a familiar base environment without any visual distractions. The bare-bones environment created a digital space where some players felt comfortable exercising. In the comment section of the survey, P17 stated regarding the Low condition "It's simple but quite relaxing". P21 also provided similar feedback "I like it and I prefer this one. It may be boring but it is simple and does not overstimulate and overwhelm me". Although the Low condition was preferred for working out use-cases, 42 out of 62 participants spoke negatively towards the Low condition. Almost half of which used the word 'boring' in their comment. The lack of visual appeal and repetitive features do little to hold the player's attention. Although this may be preferred by some when exercising, it may also result in situational ineffectiveness.

As there is a lack of visual feedback and celebration for the player input, the user does not feel as connected and integrated into the experience of the game. In contrast, the Medium and High conditions were rated as overall more enjoyable with embellishments that were shown to create more intrinsic motivation within the participants. When prompted to comment on the High condition, P78 wrote "I find this interface as the most engaging, because of numerous colours and animations which stimulate my brain and help me to motivate myself to perform better" " As stated in previous sections, in certain circumstances the addition of juicy elements may be a double-edged sword. With the increase of juicy elements and enjoyment, also comes the increase of cognitive load and in some cases may trigger negative emotions such as anxiety and overall frustration. 41 out of 62 participants that left comments on each of the conditions wrote a negative comment regarding the High condition, often stating it is overwhelming, has too many animations and is mentally draining. P24 stated "Too much stuff is happening on screen, it makes me kinda uncomfortable", many of the other participants had similar comments including P49 who mentioned the drawbacks they envision when used while exercising, "This has too much going on, too much to look at. You could be easily distracted or even causes light headache after or during exercise".

The differences between the experience of Low, Medium and High juicy conditions are most largely seen between the lowest level of embellishment and any embellishment-regardless of whether it is a little or a lot. The Low condition is shown to be favourable for a less stressful bare-bones experience that may be more fitting for some. In contrast, the more embellished conditions offer a more prominently enjoyable and fun experience.

As mentioned previously, it is hard to judge an exercise application without immersing the users in the activity. There is a chance that the reason the users selected the Low condition as the more desirable in terms of working out, is because it feels more familiar and in tune with traditional forms of exercise. This theory is supported by additional information provided by the participants at the beginning of the survey where they were asked to disclose how they achieved their daily exercising requirements. 88% of the participants indicated that they work out at home alone which corresponds fairly well with the percentage of users choosing the Low condition over either Medium or High when answering which would encourage them to work out more frequently.

Through previous research, it can be said juicy game design has an influence on how a game is perceived and in some ways dictates the relationship the game has with the player [4, 27, 54]. Therefore, the influence that juicy game design has on the media in which it is implemented may be heavily tied to the existing attitudes and expectations players have. For example, if the user is used to a minimalist gym environment where the core focus is on performing tasks correctly, an embellishment-packed fitness environment

may cause additional stress as it does not comply with the player's existing mental model of working out.

5.1.3 Discussion Summary

The results examined above can be summarized into several main understandings.

The first is that even a small amount of embellishment can go a long way in terms of experience. In both the PANAS as well as the comparison survey section, medium, and high levels of juiciness had similar results in terms of positive user experience while the Low juice condition was rated overall significantly lower. There is also not a large difference in preference between the Medium condition and the High conditions. This is shown through the higher rate of neutral answers when choosing between High and Medium conditions.

Where energy and excitement are concerned, more embellishments are better than none at all. However, there may be a threshold of juicy game design where more embellishments become ineffective at creating an enjoyable digital environment. In the PANAS, both the Medium and High conditions had a higher negative affect as well as a significantly higher positive affect score than the Low juice condition. This is mimicked in the comparison study where it can be seen that the two more embellished conditions score better than the Low condition on positive keywords such as "enjoyable, engaging and motivating". When comparing the High and Medium conditions, the high condition is consistently chosen less frequently than the medium condition. It also has a higher selection rate when asked which condition is seen as more "boring". This suggests that perhaps there is a limit on the amount of juicy design that is needed in order to create more rewarding user experiences. The advantage that a low amount of embellishments has over more embellishments is reduced feelings of mental taxation and overwhelming feelings, but this then sacrifices other feelings of enjoyment and leads to boredom. The balance between the juicy extremes is important to the overall user experience and may need to ebb and flow along with the pace of the media to which it is applied in order to efficiently make use of embellishments while not overwhelming, or boring the user.

5.2 Juicy Application

The dual nature of applying embellishments to games means that they cannot be applied in every circumstance with the same magnitude. There is also something to be said about personal preference and individual information processing abilities. The overarching guide

to application, however, is that any game should possess at least some level of Juicy design elements. Through the results garnered it is clear that embellishments create a more engaging and motivating game space. Where an exercise context is concerned, more research should be conducted in order to better understand where embellishments may be used to benefit exergame experience. Although this study shows a significant preference towards lower visual embellishment levels, based on previous research, it is fair to assume that there exists a balance in which embellishments are not distracting to the player while encouraging visual engagement and excitement.

The stimuli in this study applied juicy game design elements to all segmented sections of the game screen. The sections include the UI (four corners of the screen), hit/miss indicators, gameplay main screen, and game background. Thus, the results shown are reflections of juicy game design being applied in a full capacity. Within this research, there is some evidence that the outlined sections are processed differently and require different levels of juiciness between elements. For example, within the comments in the Low condition, 4 users specifically mention the lack of colour and background as a severe drawback but express enjoyment towards the simplicity. When looking at the High juice condition, there are a lot of comments stating the condition is too overwhelming, yet in many of the comments, users also point out enjoying the glowing yellow stars. This illustrates that for complex applications that require high levels of focus, using a standard level of juicy design across all elements may not be as effective as tailoring each element.

Based on the findings listed above, future research and juicy game design applications should be conscious of different cognitive, and emotional effects. Special attention should be given to individual levels of juiciness in different game screen segments, rather than ensuring consistent application throughout all game features.

5.3   Research Objectives

The research objectives of this thesis was to investigate how various types of embellishments affect participants' perceived enjoyment of exercise media, and how embellishments affect participants' motivation to exercise.

5.3.1   Enjoyment of Exercise Media

In order to investigate the influence of embellishments on the enjoyment of exercise media, stimuli used in the survey study were based on an existing exergame *Sphery Racer*. Levels

of juicy design were determined by analyzing and then categorizing features of each level as reported by previous research in Juicy game design. The synthesized levels were then validated by game designers at Sphery and implemented into the survey. The PANAS [65] and a customized comparison questionnaire were used together to gather data on user enjoyment.

Findings show enjoyment of media is heavily tied to whether or not there is any presence of embellishment. Although, enjoyment does not increase with the number of visual embellishments present.

5.3.2 Exercise Motivation

To investigate how embellishments may influence exercise motivation, participants were primed with an exercise-based scenario before responding to survey materials. Along with the primers, the survey also included questions that directly addressed exercise and motivation and asked participants to choose between different conditions to indicate a preference. The participants were also asked to disclose their exercise habits and preferences in order to gain a better understanding of how participant backgrounds may influence embellishment preferences.

Findings show that less visually embellished stimuli appear favourable to participants as an encouragement to work out more frequently. Less visual embellishments also result in an overall more boring and lacklustre experience.

5.4 Limitations

Throughout the survey, there were several issues that were noticed retrospectively including some questions not being coded as mandatory for completion. This was addressed throughout the methodology, and all participants with incomplete answers were fully removed from the analysis. Another limitation of the survey method itself comes from the logistics of an anonymous survey. From the beginning, the survey was fully anonymous and was administered through a third-party platform. As a result, there was no way to hold participants accountable for not completing the survey to the best of their ability. Although there are attention check questions throughout the possibility of user error still exists within this methodology.

As a key part of the survey, the conditions were created by the researcher independently. They were then peer-reviewed and shown to the ExerCube design team upon completion.

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As a result of the development process and evaluation from the team at the end of the design life-cycle, there was a missed opportunity to be more accurate and true to the original nature of the game as seen by the developers.

It is equally important to note, the research questions and goals were originally composed with in-person research and methodology in mind. Due to the COVID-19 pandemic, adjustments needed to be made. Instead of using the Exercube as part of the methodology, GIFs were created based on the digital experience of the game and participants were given a use-case scenario while completing the survey. Measuring perception of juiciness in an exercise context is not as effective as measuring in-person affect with participants engaging and exercising within the Exercube. This results in the limitation of the intended findings of this research.

5.5   Future Work

This research provides a basis on which in-person juicy game design exercise research can be based upon. Further research can be conducted to quantify the number of embellishments being used at different engagement points in a game. Conducting such research would act as the next step toward creating Juicy design guidelines that can be implemented in research and industry use. This would also help in identifying where the threshold is between juicy levels and aid in the appropriate application. Furthermore, examining how implementing juicy game design elements to different sections of a game screen, may provide valuable input on situational juicy game design applications. This can also lead to creating more accessible embellishments and introduce player choice into when they see embellishments and to what capacity.

Another avenue that may be pursued is Juicy design applications in fast-paced games. This research has found that along with increased amusement and positive in-game feelings, high levels of Juicy game design may also add feelings of stress and mental taxation. In conjunction with the findings of this research, where lower levels of embellishments were preferred for exercise contexts, examining high-stress games through a juicy design lens may help improve the overall experience for such games.

Chapter 6

Conclusion

This work builds on previous research conducted in the HCI and Games User Research (GUR) space by comparing three separate levels of juicy game design through a survey study. With a focus on player experience and motivation, I validate previous findings surrounding juicy game design and add initial research on how embellishments may influence players in exergames.

High and Medium levels of juicy game design were shown to be significantly more enjoyable than the Low levels, indicating that even a small amount of embellishments goes a long way for positive player emotions. Unlike in previous research, the Low juicy condition showed some advantages in its potential application. Lower levels of juicy game design, although rated more boring overall, were chosen significantly more often than the High and Medium conditions when asked which would encourage participants to work out more frequently.

Digital application and game designers alike can make use of these findings by implementing juicy game design in moderate amounts to supplement user interactions. This thesis provides supporting evidence and some additional insight on the implication of different juicy game design levels. It also introduces the contradiction of previous results when applied to an exergame setting and opens avenues for future research.

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APPENDICES

Appendix A

1

Study Information

Game Design Questionnaire

11/9/2022

Principal Investigators: Lennart Nacke, Associate Professor, Stratford School of Interaction Design and Business, Stratford, Ontario len@uwaterloo.ca

Student Investigators:

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Hello and welcome to our survey on exergames and embellishments! This is a survey study examining visual embellishments in an exercise game (exergame) context.

Exergame embellishment and resulting effects: Exercising is an important part of a daily routine, but is often neglected because of little time, lack of enjoyment or priority. This can lead to several adverse effects on both mental and physical health. To complete the minimum amount of exercise recommended per week, efforts have been made toward creating engaging modes of exercise through gaming. This study seeks to better understand how different levels of embellishments affect user exertion and perception of the physical activity tasks.

You are invited to participate in this study, where you will be asked to: complete an online survey through Qualtrics. **Questions will ask you to provide your demographic information (age and gender) that you may choose to decline to answer.** The survey will also ask about thoughts and feelings towards fitness, exercise and different levels of visual embellishments.

To be eligible for this study, you must be at least 18 years old, have the ability to see images and text on a digital screen, and have access to a computer, phone or tablet that can connect to Qualtrics.

With your permission, we will collect **anonymous survey results and store them securely for up to 7 years on a** database accessible only to the investigators.

TIME COMMITMENT: Your participation in this study, which is approximately 3**0 minutes,** is entirely voluntary and you may refuse to participate or withdraw from the study at any time up until the point at which your data is submitted.

RISKS & BENEFITS: This study contains no risks. There are no direct benefits to participants, but the results will benefit the scientific community – it will inform future research and design of the effects of exergame technology.

CONFIDENTIALITY: This survey is anonymous in that it will not ask for your name or other identifying information (e.g., e-mail address). Data may be deposited in an online public repository/database. This process is integral to the research process as it allows other researchers to verify results and avoid duplicating research. If not shared, it will be kept on a secure OneDrive account. Your identity will be confidential. When information is transmitted over the Internet, privacy cannot be guaranteed. There is always a risk your responses may be intercepted by a third party (e.g., government agencies, hackers). University of Waterloo researchers will not collect or use internet protocol (IP) addresses or other information which could link your participation to your computer or electronic device without first informing you.

WITHDRAWAL: Given that the survey is anonymous, it will not be possible to remove your data from the study after you submit your responses because the researchers will have no way of identifying which responses are yours.

REMUNERATION: Participants will receive remuneration of **£ 4.50 or roughly $6 CAD (subject to conversion rates)** sent to their Paypal account through Prolific.com. If participants are interested in following the results of the study, they can contact the researcher with a request. This research is conducted by the HCI Games Group. You may decline to answer any question(s) you prefer not to answer by skipping to the next question. Further, you may decide to end your participation in the survey at any time by closing your browser. If you decide to withdraw from the survey, please return to the study page in prolific and contact the primary researcher Ekaterina Durmanova so that you may receive the payment amount.

For all other questions or requests to receive information on the results of the study, contact Ekaterina Durmanova at edurmano@uwaterloo.ca.

The researchers will answer any questions you have about this survey at their earliest convenience and can be reached through the emails provided above.

This study is funded by the Tri-agency / CIHR - Canadian Institutes of Health Research. Results from this study will be used as part of a Master's level thesis as well as in potential publications.

This study has been reviewed and received ethics clearance through the University of Waterloo Research Ethics Board (REB [43840]). If you have questions for the Board contact the Office of Research Ethics, at 1-519-888-4567 ext. 36005 or reb@uwaterloo.ca.

A copy of this agreement can be retained by selecting the text and copying (right-click and select copy or press CTRL + C) the information, then pasting it into an open document.

By providing your consent, you are not waiving your legal rights or releasing the investigator(s) or involved institution(s) from their legal and professional responsibilities.

I have read the information presented in the information letter about a study conducted by Ekaterina Durmanova, under the supervision of Dr. Lennart Nacke, Stratford School of Interaction Design and Business, University of Waterloo. I have had the opportunity to ask questions related to the study and have received

satisfactory answers to my questions and any additional details.

With full knowledge of all foregoing, I agree, of my own free will, to the following statements. (You must agree to all terms to proceed with the survey.)

☐ I am 18 or over and I agree to participate in this study.

Demographic

Which gender do you identify with most?

○ Man

○ Woman

○ Non-binary

○ Prefer not to say

○ [   ] Prefer to self-describe

Please input your age in years.

[   ]

Exercise Habits

Leisure Time Exercise Questionnaire
Considering a 7-day period, how many times on average do you do the following kinds of exercise for more than 15 minutes (write in each box the appropriate number).

a) Strenuous Exercise (Heart Beats Rapidly)
(i.e. running, jogging, hockey, football, soccer, squash, basketball, cross country skiing, judo, roller skating, vigorous swimming, vigorous long distance bicycling)

Input number of sessions of 15+ minutes per week:

```
[                                                    ]
```

b) Moderate Exercise (Not Exhausting)
(i.e. fast walking, baseball, tennis, easy bicycling, volleyball, badminton, easy swimming, alpine skiing, popular and folk dancing)

Input number of sessions of 15+ minutes per week:

[ ]

c) Mild Exercise (Minimal Effort)
(i.e. yoga, archery, fishing from river bank, bowling, horseshoes, golf, snowmobiling, easy walking)

Input number of sessions of 15+ minutes per week:

[ ]

Please indicate your agreement with the following statements about your exercise habits and experiences.

	Strongly Disagree	Somewhat disagree	Neither agree nor disagree	Somewhat agree	Strongly agree
I enjoy strenuous exercising	○	○	○	○	○
I enjoy medium exercising	○	○	○	○	○
I enjoy mild exercising	○	○	○	○	○
I make time to consistently exercise	○	○	○	○	○

I primarily exercise:

☐ alone in a gym
☐ alone at home
☐ through organized classes
☐ using digital exergames (games with fitness or exercising elements)
☐ by playing sports
☐ online classes (live or recorded)
☐ [   ] other

Please drag and drop the following **exergames** (games with fitness or exercising elements) types into the categories that best fit.

Items

Just Dance

Wii Fit

Xbox Kinect Games

VR Beat Saber

Ring Fit Adventure

Other Not Listed

[   ]

I have played this before

I have seen or heard of this before, but have not played

I have not heard of this

For the exergames that you have played before, please indicate **how often** you have played them:

Items	I regularly play this game (once a week or more)
Just Dance	
Wii Fit	
Xbox Kinect Games	
VR Beat Saber	
Ring Fit Adventure	
Other Not Listed	I used to play this game regularly but I do not any more
	I only played this once or twice

I have never played this

Juicy Comparison Qs

You will now be asked to compare various exergame examples, please select your answer based on your own personal feelings.

The images in this section were constructed by stitching together several still frames. Please focus on the features of the interface rather than the smoothness of the gifs when selecting your answers.

PANAS - Med Juice

Please consider the following user interface:

Indicate the extent to which you feel the following when considering the user interface above.

	Please select an option for each statement				
	Very slightly or not at all	A little	Moderately	Quite a bit	Extremely
Interested	○	○	○	○	○
Distressed	○	○	○	○	○
Excited	○	○	○	○	○
Upset	○	○	○	○	○
Strong	○	○	○	○	○
Select 'Very slightly or not at all'	○	○	○	○	○
Guilty	○	○	○	○	○

	Please select an option for each statement				
	Very slightly or not at all	A little	Moderately	Quite a bit	Extremely
Scared	○	○	○	○	○
	Very slightly or not at all	A little	Moderately	Quite a bit	Extremely
Hostile	○	○	○	○	○
Enthusiastic	○	○	○	○	○
Select 'Moderately'	○	○	○	○	○
Proud	○	○	○	○	○
Irritable	○	○	○	○	○
Alert	○	○	○	○	○
Ashamed	○	○	○	○	○
Inspired	○	○	○	○	○
	Very slightly or not at all	A little	Moderately	Quite a bit	Extremely
Nervous	○	○	○	○	○
Select 'Quite a bit'	○	○	○	○	○
Determined	○	○	○	○	○
Attentive	○	○	○	○	○
Jittery	○	○	○	○	○
Active	○	○	○	○	○
Afraid	○	○	○	○	○

PANAS - High Juice

Please consider the following user interface:

Indicate the extent to which you feel the following when considering the user interface above.

	Please select an option for each statement				
	Very slightly or not at all	A little	Moderately	Quite a bit	Extremely
Interested	○	○	○	○	○
Distressed	○	○	○	○	○
Excited	○	○	○	○	○
Upset	○	○	○	○	○
Strong	○	○	○	○	○
Guilty	○	○	○	○	○
Scared	○	○	○	○	○

	Please select an option for each statement				
	Very slightly or not at all	A little	Moderately	Quite a bit	Extremely
Hostile	○	○	○	○	○
	Very slightly or not at all	A little	Moderately	Quite a bit	Extremely
Enthusiastic	○	○	○	○	○
Select 'Moderately'	○	○	○	○	○
Proud	○	○	○	○	○
Irritable	○	○	○	○	○
Alert	○	○	○	○	○
Ashamed	○	○	○	○	○
Select 'Quite a bit'	○	○	○	○	○
Inspired	○	○	○	○	○
	Very slightly or not at all	A little	Moderately	Quite a bit	Extremely
Nervous	○	○	○	○	○
Determined	○	○	○	○	○
Attentive	○	○	○	○	○
Select 'Very slightly or not at all'	○	○	○	○	○
Jittery	○	○	○	○	○
Active	○	○	○	○	○
Afraid	○	○	○	○	○

PANAS - Low Juice

Please consider the following user interface:

Indicate the extent to which you feel the following when considering the user interface above.

	Please select an option for each statement				
	Very slightly or not at all	A little	Moderately	Quite a bit	Extremely
Interested	○	○	○	○	○
Distressed	○	○	○	○	○
Excited	○	○	○	○	○
Upset	○	○	○	○	○
Strong	○	○	○	○	○
Select 'A little'	○	○	○	○	○
Guilty	○	○	○	○	○

	Please select an option for each statement				
	Very slightly or not at all	A little	Moderately	Quite a bit	Extremely
Scared	○	○	○	○	○
	Very slightly or not at all	A little	Moderately	Quite a bit	Extremely
Hostile	○	○	○	○	○
Enthusiastic	○	○	○	○	○
Proud	○	○	○	○	○
Irritable	○	○	○	○	○
Alert	○	○	○	○	○
Ashamed	○	○	○	○	○
Inspired	○	○	○	○	○
Nervous	○	○	○	○	○
	Very slightly or not at all	A little	Moderately	Quite a bit	Extremely
Determined	○	○	○	○	○
Attentive	○	○	○	○	○
Jittery	○	○	○	○	○
Active	○	○	○	○	○
Afraid	○	○	○	○	○
Select 'Extremely'	○	○	○	○	○

High - Medium

Interface 1   Interface 2
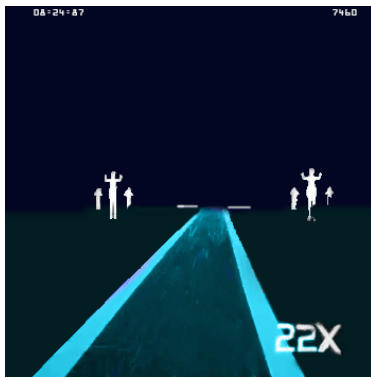
Look at the interfaces one at a time, which interface would you find more:

	Interface 1	Interface 2	Neither / Both equally
Boring	○	○	○
Overwhelming	○	○	○
Engaging	○	○	○
Confusing	○	○	○
Mentally taxing (I find this tiring to focus on)	○	○	○
Motivating	○	○	○
Enjoyable	○	○	○
Please select Interface 1	○	○	○

High - Low
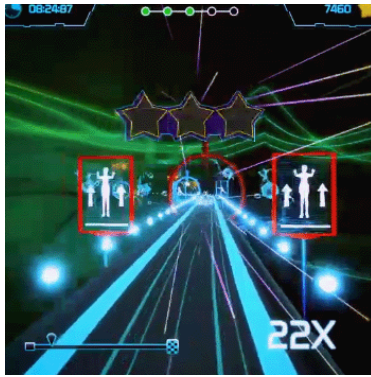
Interface 1   Interface 2

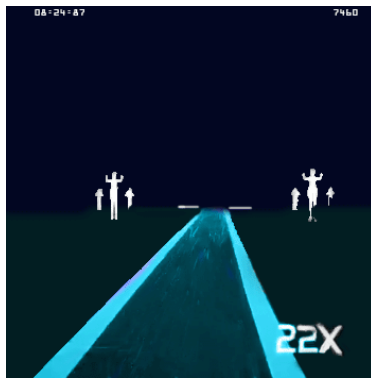Look at the interfaces one at a time, which interface would you find more:

	Interface 1	Interface 2	Neither / Both equally
Boring	○	○	○
Confusing	○	○	○
Overwhelming	○	○	○
Motivating	○	○	○

	Interface 1	Interface 2	Neither / Both equally
Enjoyable	○	○	○
Engaging	○	○	○
Mentally taxing	○	○	○

High – Low

Interface 1	Interface 2
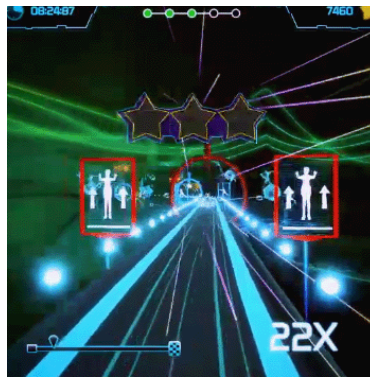
Look at the interfaces one at a time, which interface would encourage you to:

	Interface 1	Interface 2	Neither / Both equally

	Interface 1	Interface 2	Neither / Both equally
Please select "interface 1"	○	○	○
Work out during longer sessions	○	○	○
Work out more frequently	○	○	○

Med - Low

Interface 1   Interface 2
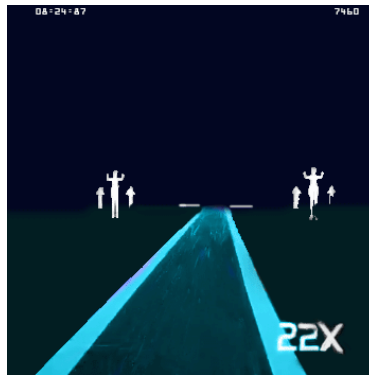
Look at the interfaces one at a time, which interface would you find more:

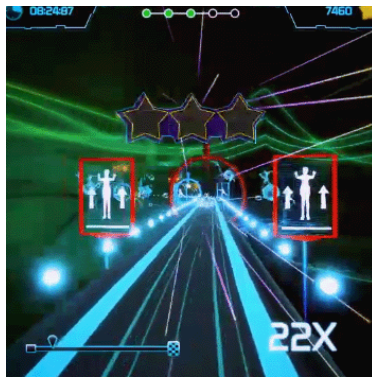|	Interface 1	Interface 2	Neither / Both equally
Overwhelming	○	○	○
Boring	○	○	○
Motivating	○	○	○
Confusing	○	○	○
Engaging	○	○	○
Enjoyable	○	○	○
Mentally taxing	○	○	○

Med - Low

| Interface 1 | Interface 2 |

Look at the interfaces one at a time, which interface would encourage you to:

	Interface 1	Interface 2	Neither / Both equally
Work out more frequently	○	○	○
Please select "interface 2"	○	○	○
Work out during longer sessions	○	○	○

High - Med

Interface 1   Interface 2

Look at the interfaces one at a time, which interface would encourage you to:

	Interface 1	Interface 2	Neither / Both equally
Work out more frequently	○	○	○
Please select "neither / both equally"	○	○	○
Work out during longer sessions	○	○	○

Additional Comments 1

Do you have any additional comments about the interface shown above?

[   ]

Additional Comments 3

Do you have any additional comments about the interface shown above?

[   ]
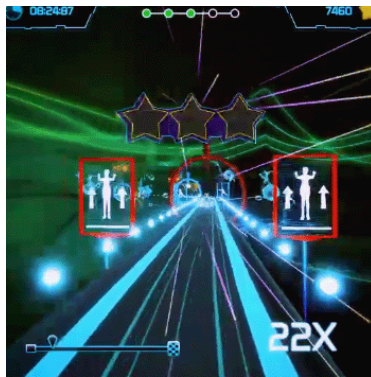
Additional Comments 2

Do you have any additional comments about the interface shown above?

[   ]

Thank you

Project Title: Exergame Embellishments and The Resulting Effects

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We appreciate your participation in our study, and thank you
for spending the time helping us with our research!

For your participation, you will receive remuneration of £ 4.50
or roughly $6 CAD (subject to conversion rates) sent to the
Paypal account connected to Prolific.com once you click
through to the redirection link and follow the given instructions
on Prolific.com.

 In this study you were asked to participate in an online 30-
minute anonymized Qualtrics survey study. You were
instructed provide your opinions on different levels of
embellishments in an exergame context. The focus of the

study was to provide the initial steps to understand how we can improve exergame technology to better motivate, engage and entice players.

Your identity is considered completely confidential; because the interest of this study is in the average responses of the entire group of participants, you will not be identified individually in any way in any written reports of this research. Once all the data is collected and analyzed for this project, I plan on sharing this information with the research community through seminars, conferences, presentations, and journal articles.

Electronic data will be retained for a minimum of 7 years on a secure password protected computer to which only researchers associated with this study have access. Your identity will be confidential.

This study has been reviewed and received ethics clearance through a University of Waterloo Research Ethics Board (REB #43840). If you have questions for the Board contact the Office of Research Ethics, at 1-519-888-4567 ext. 36005 or reb@uwaterloo.ca. For all other questions, or requests to receive information on the results of the study, contact Ekaterina Durmanova at edurmano@uwaterloo.ca.

We really appreciate your participation, and hope that this has been an interesting experience for you.

Glossary

ACM Association for Computing Machinery Digital Library 18

AR Augmented Reality 13

GIF Graphics Interchange Format 18, 23, 24

GUR Games User Research 48

HCI Human Computer Interaction 10, 13, 48

NA Negative affect 30, 31

PA Positive affect 30, 31

PANAS Positive and Negative Affect Schedule iii, 7, 8, 16, 27–33, 36, 41, 44, 46

PX Player Experience 11, 12

UI User Interface 3, 21, 23–25, 45

VEs Visual embellishments iii, 1, 9, 10, 12

VR Virtual Reality 2, 13, 14

WHO World Health Organization 6