Juicy Game Design: Exploring the Impact of Juiciness on the Player Experience

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Abstract

Visual embellishments (VEs) are design elements that support information already conveyed by other means. In games, a similar concept is known as *juiciness*, and refers to the provision of superfluous feedback in situations where a single player action triggers multiple non-functional reactions. Elements that could be considered VEs are commonly found in games as a way of improving the feedback loop of the game. While feedback elements have been previously investigated, juiciness remains relatively undefined and is underexplored.

In this thesis, this issue is addressed through the creation of an empirically grounded definition of juiciness, and an empirical exploration of how the concept affects player experience. First, this project presents a literature review of existing research in this area, exploring the undying motivation through interaction design principles. It then presents a framework for juicy design built from a survey of game designers perspectives. This framework is then applied through several user studies that explore the impact of juiciness on player experience. The first user study explores the effects of VEs with 40 participants comparing the effects of visual embellishments in two research games created, the Frogger-clone Cuber, and the FPS game Dungeon Descent. The second study explores the effects of juiciness through the commercially available game Quake 3 Arena with 32 participants. Building from this, two further user studies are presented, exploring the effects of VEs in-the-wild through the deployment of the game Cuber, and through a within-subjects study of juiciness and gamification with 36 participants using an existing research simulation from the life sciences as research tool.

This thesis defines juiciness as coherent design of game mechanics and visuals, while providing confirmatory, explicit and ambient feedback. The results of the empirical

work carried out within this thesis show that the effects of juiciness are nuanced, and can vary depending on both the implementation and context of the juiciness. This work reveals that juiciness has the potential to target intrinsic motivation factors and increase the visual appeal of a game. Lastly the overall findings of the thesis are summarised, followed by a discussion of the wider implications of juiciness, and its relevance for game development.

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Chapter 1

Introduction

Visual embellishments (VE) are design elements that have no effect on system functionality, but contribute to the overall experience that users have [9]. In the context of games, VE can refer to enhancing the feedback loop, for example, by including a large amount of feedback based on a single input from the player [77]. This type of feedback – where one small player action can have multiple visual and auditory game reactions – has also been classified as "juicy" by both industry and academia [31, 75]. Juiciness is a game design term that has been used by game developers and researchers to denote an abundance of feedback effects in a game, leading to an experience that feels slick and smooth to play [77, 75]. An example of juiciness is offered by the casual puzzle game *Peggle* : when the player successfully finishes a level, they are showered with visual and audio feedback, reinforcing the message that they have completed the level across several communication channels at once, with the goal of increasing perceived player competence and a sense of achievement [142]. Here, it is important to note that these juicy embellishments are usually not tied into gameplay mechanics and commonly have no real impact within the game, instead being reserved to provide feedback to the player. Another example of this are screen shakes (where the game camera shakes to convey the impact of a game event), e.g., an effect used when a player lands after jumping in the first-person shooter *Overwatch* . Schell [133] proposes the lens of "juiciness" as a way of designing game interfaces that give continuous feedback to the player, maximising perceived reward. While adopting different definitions, existing work generally acknowledges that "juicy" game elements have an effect on the player experience. For example,

Swink [142] suggests that good feedback in association with other aspects of "game feel" will make players perceive a game as more rewarding. Despite these practical descriptions of juiciness, there is no empirical definition of what constitutes a juicy game, and no empirical evidence of how juiciness contributes to player experience. While researchers have previously touched upon some aspects of juiciness, there is a clear lack of work exploring the effects of juiciness on player experience - a gap in our knowledge that this thesis addresses, through a systematic, empirical examination of the idea of "juiciness". It achieves this by exploring the aspects of juiciness such as visual embellishments, feedback that is directly integrated into game elements and informs players of their action visually. This thesis further explores what elements of games contribute to them being perceived as "juicy". Acknowledging the hypothesised link between psychological elements of player experience (e.g., perceived competence [31]), this thesis draws from Self-Determination Theory (SDT) as a lens for analysis.

SDT is a motivational theory that defines several human needs that need to be satisfied to foster intrinsic motivation [24]. In games research, SDT has been leveraged as a tool for exploring player experience [98], prior academic work has hypothesised that juiciness increases the player experience through targeting needs satisfaction, such as the need for feeling competent [31]. This thesis primarily uses SDT as a way of analysing the relationship between juicy elements and player experience, contributing to the theoretical understanding of what makes for a positive player experience, and to explain study results on how players experience 'juicy' games.

1.1 Problem Statement

Most academic research that discusses juiciness defines it as when a game gives the player continuous feedback for their actions, and reacts in many ways simultaneously [133]. Previous research highlights how it is constructed as superfluous and rewarding feedback that forms part of a complete game experience and is worth taking the time to include when creating a game [133, 77, 31]. However, the existing research does

not offer one unified definition of what juiciness is, and while it is frequently stated that it will make the experience more rewarding and enjoyable for the player, this observation is anecdotal, and not backed by empirical evidence. Academics state that juiciness should be included in order to make more rewarding and positive game experiences but due to the intangible definition they neglect to state how to make an experience juicy or how it will specifically effect the experience. This poses an issue with how the literature is saying to include these juicy aspects but provides no way of doing so while also neglecting data to see what effect juiciness has. Game designers also take a practical approach. Industry talks and articles offer insights on how important juiciness is to player experience, and how it will make games 'feel' better to play [142, 75, 46]. However, game developers do not explicitly state what juiciness is, or how it will make the games better. Which elements contribute to juiciness therefore still remains vague. In conclusion, juiciness is acknowledged and used as a design term but has not been researched empirically: an understanding of the effects juicy elements can have on the player experience is needed.

This results in a twofold problem that is addressed in this thesis: first, the term juiciness is intangible and vague, and it is not clear or actionable how to make a game juicy. Second, both game developers and academics propose that juiciness has a wealth of positive effects on player experience, but there is no empirical evidence to back these claims up or to further explain individual effects. It is therefore necessary to create an empirically grounded and uniform definition of juiciness, and to examine the effects that it can have on player experience.

1.1.1 Research Questions

This thesis sets out to define and examine the concept of juiciness in a detailed and empirical fashion. To this end, this thesis seeks to address two main research questions:

Research Question 1: How can we define juiciness in the context of games, and which game elements contribute to it?

Juiciness is currently lacking an empirical definition. This poses an issue in that it clouds discussion, and prevents future work studying juiciness in a structured way. This question seeks to address this issue through asking how juiciness can be defined. Additionally, this question seeks to investigate how juiciness is constructed, i.e., which (game) elements contribute to a game being perceived as juicy. Through this definition and understanding of juiciness, researchers can then begin to explore the effects of the concept on player experience.

Research Question 2: How does Juiciness contribute to player experience, and are its effects different from alternative approaches to engage users?

Literature suggests that juiciness leads to improvements in player experience, often on the basis of improved visual appeal [142, 77]. Additionally, previous work suggests that juiciness contributes to intrinsic motivation by addressing factors such as player competence [31]. This research question therefore investigates how juiciness contributes to the player experience from several different angles, looking at how juiciness affects intrinsic motivation, visual appeal, and player performance, and what the overall contribution of the concept to general player experience is.

1.2 Contributions

This thesis makes the following three main contributions:

1. It provides the first empirically grounded definition of juicy design, demonstrating that juiciness is a complex and nuanced design term that extends beyond feedback, touching on every aspect of the game. It is not enough to simply include more feedback for player actions, the context and coherence of the game are need to considered. For example when trying to create a juicy experience before focusing on feedback (confirmatory, explicit, ambient, superfluous), the mechanics, visuals, and audio need to be both thematically and mechanically coherent. This definition is treated as a working definition.

2. It provides a validated framework to aid the analysis of juiciness. The frame-

work is built using the empirical definition of juiciness, and provides a way of analysing juiciness that is actionable for researchers and practitioners.

3. It provides a series of structured studies exploring how juiciness contributes to player experience, showing that juiciness can affect all aspects of intrinsic motivation, but that this depends on the quality of the implementation and genre of game. The findings also reveal that juiciness improves other aspects of player experience by increasing perceived visual appeal of the games.

In addition to these main contributions, this thesis makes additional contributions in the following areas:

1. It provides the first structured study of visual embellishments in games and how they affect the player experience, revealing that visual embellishments have the potential to improve aspects of intrinsic motivation.

2. It shows that while juiciness can affect numerous aspects of player experience, it does not alter game task performance, although players feel that they perform better in juicy games.

3. It provides a structured comparison of juiciness and gamification, highlighting how they are both able to provide similar contributions to the player experience, and that juiciness can be leveraged as alternative to gamification in settings where elements such as badges, points and leaderboards are not desirable.

4. It provides details on the suitability of adding juicy elements to existing research tools.

5. It offers insights into diverse case studies and deployment settings that can help inform the work of researchers wishing to explore the concept in the future.

1.3 Thesis Overview

This thesis is structured into eight chapters. This first chapter provides the introduction to this thesis. The second chapter introduces the topic of juiciness and

provides the foundation for the rest of the thesis based on existing literature surrounding juiciness from academic games research, games user research, and industry discourse. The third chapter looks at game designer perspectives of the term and then presents the construction and validation of a framework for juicy design. The fourth chapter applies this framework in the design and evaluation of two research games used as case studies to explore the isolated effects of visual embellishments on the player experience. The fifth chapter then explores and evaluates juiciness further in comparison to gamification. The sixth chapter explores the effects of juiciness in a deployed game setting looking at first time user experience and engagement. The seventh chapter collates and summarises the findings from all these studies highlighting their contributions while the eighth chapter discusses the wider implications of juicy design for both games user researchers and industry practitioners. Lastly, chapter eight presents a conclusion to the work in this thesis and highlights interesting directions for future work.

1.3.1 Chapter 1: Introduction

This chapter presents the structure of the thesis, it introduces the concept of juiciness and briefly discusses existing work in the area. This chapter presents a problem statement on juiciness that helps to motivate the rest of the work and informs the two overarching research questions that are answered throughout this thesis. Lastly this chapter highlights the contributions of the work.

1.3.2 Chapter 2: Related Work

This chapter provides background information on existing work that explores juiciness as a whole, but also work that examines related aspects such as feedback elements and VEs. It also gives an overview of work that explores the concept of player experience and how that is constructed and measured. The chapter then also explores the player experience through the concept of SDT and intrinsic motivation, and summarises relevant work on the beauty of things and pleasure of use.

1.3.3 Chapter 3: Defining Juiciness

Based on the preceding analysis of related work, this chapter first presents a motivation for an empirically grounded definition of juiciness, then addresses this issue through a combination of industry perspectives and academic analysis to create a more detailed understanding of what contributes to juicy design. Results from an online survey of game developers' perspectives on juiciness are used as the foundation of a framework for juicy design. A validation of this framework is then presented through the application to two commercially available games. Thereby, the framework is further refined as a tool that makes the concept of juiciness actionable for researchers and designers.

1.3.4 Chapter 4: Studying Juiciness

Using the framework for juicy design created in the previous chapter, this chapter presents details on the design, evaluation, and analysis of two case studies exploring the effect of visual embellishments on the overall player experience and perceived beauty of research games and commercially available games. The first study compares the effects of visual embellishments in two research games, Frogged Cubed and Dungeon Descent; the second study also compares the effects of visual embellishments using a commercially available game, *Quake III Arena*. Results show that visual embellishments contribute to the visual appeal of all games, but only affects aspects such as competence under specific circumstances.

1.3.5 Chapter 5: Juiciness In-The-Wild

Building on the previous studies, this chapter presents a case study exploring the potential effects of juicy design on the first-time player experience. This study makes use of the research game *Frogged Cubed* used previously in chapter four. The first-time user experience was evaluated though an in-the-wild deployment of *Frogged Cubed* where players were either exposed to an embellished version or a regular

version of the game. Results show that the visual embellishments had no effect on duration of the first gaming session or the number of times a player returns to the game.

1.3.6 Chapter 6: Juiciness and Gamification

This chapter presents the results of a user study that compared traditional gamification elements, and the concept of juiciness in the context of a virtual reality simulation. This study explores what effects juiciness and gamification can have on player experience both independently and when the two concepts are integrated. Results show that gamification and juiciness improve user experience, but that only juiciness fulfils all basic psychological needs that facilitate intrinsic motivation when applied in non-gaming settings. User preferences favour the combination of both approaches; however, neither improved performance, and there is evidence of juicy elements influencing user behaviour.

1.3.7 Chapter 7: Main Findings

In this chapter, the core findings of this thesis are summarised. The findings from each chapter are highlighted and the main contributions of each study are presented.

1.3.8 Chapter 8: Wider Implications of Juiciness

This chapter presents a discussion surrounding the effects of juiciness on the player experience, implications for applying juicy design principles to games and the wider implications of this work. Additionally this chapter presents a series of juicy design recommendations paired with game examples to illustrate how these implications can be used in both future games research and commercial games.

1.3.9 Chapter 9: Future Work and Conclusion

This final chapter outlines potential avenues and challenges for future work with a focus on the integration of juiciness, exploring non-visual aspects of juiciness such as audio and haptic feedback, and investigating the effect that juiciness can have on the perceived value and quality of games.

1.4 Positionality

It is important to acknowledge and understand the author's background when it comes to evaluating this work. A researcher's background and position affects both what they choose to investigate but also the direction of the investigation, the methods that are used, what results are considered interesting and how results are framed [93]. The idea of reflectivity; the examination of one's thoughts and feelings helps to guide and define an approach [48], this thesis was approached from using the authors existing perspectives on what juiciness is but also how player experience research should be conducted. This positionality statement should serve as guidance for how the author's own perspective has guided this research and in turn guides how this research should be interpreted.

1.4.1 About Me

I consider myself to be a blend between game researcher and game designer. As a researcher, I have been involved in many projects that typically sit between the lines of Human-Computer Interaction, Computer Science and Psychology. I have spent time working with specific audiences (e.g., young wheelchair users) with participatory design methods to create novel game experiences. This area of research also affects me as a game designer, just like my game design practice influences my values in research. I have spent time working as a self-employed game developer for two different companies that I founded. I have also spent time employed in the games industry as a freelancer both for game design but also rapid prototype development.

I have worked on a handful of commercially released products and this focus on making games that are commercially viable helps to inform my research approaches. An example of how my previous experience has influenced my research is through my approach toward creating research games: previous experience in games as a developer and designer highlighted to me the importance of striving to create a complete and engaging game experience to help to ensure that research participants are engaged and the results are as relatable to the world of games as possible in an effort to create ecologically valid experiences. This is evidenced through all of the studies presented in this thesis, where the games were designed to be whole experiences (as possible) with me acting as the designer leveraging from my industry experience. Additionally, my previous experience in the industry also influenced the approach that was taken to first explore and create the working definition of juiciness. While many approaches would be suitable such as drawing on existing theories of beauty in interaction [58], due to my previous experience in games development I felt that speaking to game designers first as they already have an instinctive understanding of what juiciness means to them would allow for a more grounded definition that would be useful to practitioners.

Although this is the position of the author when completing this thesis, the position of any researcher changes over time as it is not static, constantly evolving as the understanding of an area changes. My own personal perspectives of juiciness have changed throughout the course of this project, shifting from that of a designer toward that of a researcher.

1.4.2 Design Knowledge

When considering the author's background, it is worth considering the tacit knowledge they had when conducting this research and the potential for tension between game designers and research that had to be balanced. Tacit knowledge is defined as not information that is not openly expressed or stored, but implied; understood, inferred [155]. Tacit knowledge has been acknowledged as a critical component of a design team, and the sharing of such tacit knowledge is crucial to the design process

[51]. It is worth considering my own existing tacit knowledge in the context of juiciness, which as a topic is mainly transferred as a tacit knowledge that designers learn through practice rather than openly expressing. The way that design knowledge is shared has also been studied in a HCI context, again finding that as HCI researchers it's important to consider how the design lessons that are presented from research are presented to ensure they are used in the future [141], for example through accessible frameworks such as the one presented in this thesis. Previous research has looked at how this type of design knowledge can be transferred via critiques of existing work [146], a practice that was employed by myself and people I worked with in the industry and was the way juiciness was introduced to me as a concept.

My previous experience working as an independent game developer and teaching games design has shaped my pre-existing knowledge of how juiciness is constructed. When considering the study methodologies and the findings presented in this thesis it should be done so with this background knowledge of where I come from as a games designer and how that experience guides the process.

1.5 Intended Audience

There are several audiences that have a potential stake in the findings of this thesis. The primary audience that is taken into consideration in both how the results are presented and interpreted are academic game user researchers. The information in this thesis is presented in a way that should be understandable for this audience, but more importantly this thesis provides a foundation for the understanding of juiciness for future academics to use as a springboard the constructs in more specific contexts. Additionally, there is a secondary audience for this work, namely practitioners including industry games user researchers and game developers. While the thesis has not been written with solely them in mind, the findings should be accessible, while the framework is potentially useful to them as a tool they can take away from this thesis and apply it in the context of their work.

1.6 Intended Use of Findings

As previously mentioned, there are two intended audiences for the findings of this research each who will use the findings in different contexts.

1.6.1 Academics

The primary audience of academics, in particular researchers that focus on aspects of the player experience will find the results and framework from this thesis useful in several ways. Firstly through the working definition of juiciness established in Chapter 3, it is expected that academics will take this definition and further build upon both in applying it to existing experiences (research and commercial), but to also further develop and refine the definition through their own work. The findings from the user studies in Chapters 4, 5, and 6 should be used by academics to help further their understanding of not just how juiciness affects the player experience but also how small design elements that juiciness features can be used to target specific facets of the player experience. Additionally the findings can be used outside the context of games research into general interaction design, such as using the framework on non-game interactive experiences.

1.6.2 Practitioners

It is expected that the secondary target audience of this research will use the knowledge contributed in a slightly different way to academics. It is the hope that practitioners will leverage the results from the user studies as a way to gain insight into how best to design juiciness to target a particular aspect of player experience. The results in Chapter 4 found, in the commercial game the effects of juiciness were more pronounced and targeted different dimensions of the PX than in other studies, this knowledge is useful to designers to highlight how when juiciness is implemented by experienced developers it has an increased effect, helping practitioners to make more juicy experiences. The empirically grounded definition that this thesis presents may

be of some use it is expected that for many practitioners it will feel like existing knowledge, what however is expected to be useful is the juicy framework as this provides practitioners with an actionable and structured way of analysing and evaluating the juiciness of an existing game. It is hoped that the framework will be used as part of the iterative development cycle providing feedback on juiciness throughout the game development process.

1.6.3 Framework

As previously discussed, both intended audiences of this research will find use in the juicy framework that is presented in this thesis, it is worthwhile to describe what the word framework means in the context of juicy framework and how it's understood to be. The juicy framework has been designed through the empirical study of game designers perspectives on juiciness presented in Chapter 3, the framework is primarily intended to be used as an analytical tool. It is expected to be used as a tool to analyse existing playable experiences (although they may still be in development), revealing areas in which they are lacking in juiciness. What the framework is not is a generative tool, our understanding of juiciness still needs to be expanded to be able to guide the implementation of juiciness.

Chapter 2

Related Work

This chapter presents an overview of the different areas of work that this work draws upon. First an introduction and overview of what is meant by the term juiciness conceptualised through VEs, following this a section on how juiciness is currently understood from both the perspective of academia and industry. Next the concept of player experience is investigated detailing the different ways that it has been explored in previous research, it is necessary to understand how player experience is defined and measured to explore the effects juicy design could have on it. Lastly the work presented in this thesis operationalised player experience through the psychological concept of self-determination theory, thus this human motivational model is discussed and its relevance to juiciness brought together.

2.1 Conceptualising Juiciness As Visual Embellishments

This section presents a summary on the concept of VEs, that is bits of superfluous visual information that is used in the design of both interactive and passive mediums such as posters or games. This section will first detail what academic work exists around VEs in the more general Human-Computer Interaction (HCI) field and then present work specific to the gaming context tying the similarities between juiciness and VEs.

VEs are design elements that do not tie into system functionality, but support inform-

ation already conveyed by other means [9]. For example, adding an aesthetic theme to a bar graph to engage and highlight key points of information [66]. This is very similar to the concept juiciness used in the world of game design in general, although is particularly prevalent as a point of discussion among independent developers [75]. Juiciness refers to situations in which one players in-game action triggers multiple non-functional reactions within the game [77]. For example in *Rocket League*, a primarily multiplayer vehicular football game where several players each control a car and attempt to score goals through pushing a ball around through collisions. When a player scores a goal in *Rocket League* [117], the counter is incremented, and a number of visual effects are executed within seconds: the game proceeds in slow motion, all players are pushed back in a wave cascading outwards from the goal, the ball explodes with a particle effect, and the screen shakes (See 2.1). Another popular example of juiciness in games is *Peggle*, a casual puzzle game where you must destroy all the pegs in a level though correctly aiming and firing a fixed amount of balls which then cascade down the games environment hitting more pegs on the way; the physics driven nature of the game is reminiscent of Pachinko machines. Peggle [166] is also often cited as a *juicy* game through how it rewards the player with music, ascending tones and, particle effects when the player completes a level, thereby reinforcing the notion that the player is successfully progressing through the game.

Juiciness has been classified as large amounts of visual and audio feedback that games can provide to players [46, 78]. For example, Game designers have discussed the usefulness of the term [154], while industry postmortems reflect on the implementation and effect of adding juiciness [87]. While Juul's definition of juiciness primarily focuses on positive feedback [77], Swink [142] argues that both negative and positive feedback need to be considered, and draws attention to the immediacy and abundance of feedback as a core aspect contributing to a game being perceived as juicy. Swink hypothesised that juiciness can contribute to perceived player competence and overall player experience, leading to increased player engagement [142].

Figure 2.1: Pictured is a player scoring a goal in *Rocker League*, visible are the superfluous and juicy explosions effects.

2.1.1 Visual Embellishments in HCI

VEs and juiciness have previously been addressed in the field of HCI research. Here, an overview of relevant related work is presented. VEs are defined as design elements that have no effect on system functionality, but are thought to contribute to the overall user experience [9]. They primarily consist of visual information that engages the user [66]. In terms of the effects of VEs on user experience, research predominantly focuses on information visualization (e.g., graphs), and results are inconclusive. For example, Inbar et al. [71] hypothesize that VEs can improve user experience, and demonstrate that small amounts of VEs improve perceived system aesthetic. Likewise, there is ample research suggesting benefits of visual beauty (supported by VEs) for perceived usability, e.g., [58, 60, 92]. VEs can also be considered as a hedonistic aspect, that it is pleasurable to interact with them so humans seek out that pleasure [1, 57]. Hassenzhal looked into the hedonistic aspects of interaction design finding that to design a hedonic system requires an in-depth understanding of the systems goals and the fulfilment of satisfying the needs of the user such as the need for self-expression or competence [57].

In terms of the impact of VEs on cognitive load, Bateman et al. [9] demonstrate that VEs have no impact on the interpretation of information. However, findings from Borgo et al. [15] suggest that although VEs improved information recall, they also had a negative effect on the visual search speed. This suggests that the employment of VEs needs to be carefully considered. In the context of this thesis, these findings are explored further by exploring how VEs affect the perceived aesthetic of games, and their implications for player performance. Berengueres et al. applied what could be considered VEs to recycling bins through equipping them with screens to display emoticons that provide immediate feedback to increase recycling rates, and were preferred by users. This suggests that juiciness has potential to engage users particularly in non-gaming settings [11].

2.1.2 Visual Embellishments in Games

VEs and juiciness have previously been addressed by the games research communities. Here, an overview of relevant related work is presented. The games research community has begun to address the impact of VEs on player experience. Gerling et al. [49] explored the effect of visually embellishing casual games by improving graphical detail, and found that the visually embellished graphics have a positive effect on player experience. More recently Kao also explored the effects of differing levels of visual feedback through VEs [79]. Likewise, research suggests that VEs can have positive effects on task success rate in the context of serious games [150]. However, there is no research exploring the impact of VEs in games in a structured fashion. The closest related concept is that of juiciness which we cover in the following section.

2.2 Juiciness

Juiciness is a design term used in the games industry to describe a particular type of *game feel*, achieved by abundant audiovisual effects [46, 75, 77]. However, some more detailed elements of this definition remain intangible, e.g., suggestions such as

games needing to provide a "*slick*" or "*visceral*" feeling, a desirable yet vague outcome also discussed by Brown [18].

2.2.1 Existing Work Around Juiciness

This sections explores how juiciness is being utilised from both an industry perspective and how it's being investigated in academia. This section helps to frame how current academic work is lacking and points to how this can be improved through empirical studies.

Academic Research Exploring Juiciness

The concept has also been used in academia. as early as 2006, Schell [133] describes a lens for juicy design, highlighting the importance of continuous feedback. Deterding et al. [31] build upon this lens, and also addresses the sensuous nature of juiciness, and highlight its potential to contribute to perceived player competence. Swink [142] highlights that juiciness is a contributor to *positive game feel*, where positive and negative feedback need to be in balance. Swink highlights the abundance of feedback as a reason a game will feel juicy. Hunicke summarised juiciness as *"juicy feedback gives your users moment-to-moment joyful feelings when they engage with your design"* focusing on the emotions that can emerge from juiciness [69]. Juul et al. [78] provided an initial empirical investigation into the effects of juiciness on player experience, but found no significant impact of juiciness on performance or player experience when presenting players with a juicy and non-juicy version of a casual game. Kao conducted a large scale evaluation of differing levels of juicy effects in an action role-playing game, finding that juiciness can have a positive effect on the player experience providing the juiciness is not overwhelming, revealing that too much juiciness can negatively impact the player experience [79]. In both of these empirical studies and in the existing literature, a key assumption of juicy design is that it can improve player experience.

The existing work around juiciness provides evidence that the concept of juiciness

is often used to reflect on games; however, all definitions remain vague and do not lend themselves to detailed analysis or development. Addressing this issue from a theoretical perspective, Schell proposed the *Lens of Juiciness* that can be used to explore whether a game interface is juicy [133]. To this end, the lens of juiciness asks if a game is giving continuous feedback to the player for their actions and are the results of those actions rewarding. Deterding et al. used an adapted version of this lens to support gameful design, which picks up on important aspects of juicy design (e.g. the sensuous nature of juiciness, its impact on perceived competence among players, and some tangible design advice such as the careful exaggeration of feedback), but remains vague in core areas (i.e. suggests examples of sensuous experiences in the real world to inspire sensuous game design, but does not provide tangible insights into the sensuous dimension itself) [31].

Application of Juiciness in the Games Industry

From an industry perspective, game designers have previously discussed the usefulness of the term [154, 55], while industry postmortems reflect on the implementation and effects of adding juiciness to games [87]. This industry discourse on juiciness places a strong emphasis on the overall polished aesthetics of the game [102], which has also been explored in non-gaming settings in academia [58, 60]. Further, numerous game designers have presented how they perceive and design for juiciness, for example with Nijman detailing the juicy elements (e.g. slow motion to place emphasis on action and environmental permanence) that he frequently used in his games [102]. Jonasson and Purho also detailed a list of juicy elements they assume creates great feeling and juicy games (e.g. everything reacts to the player and adding sound effects with lots of bass) [75]. This theme is also reflected in further industry sources [106, 87, 91], all commenting on the importance of juicy design and outlining specific elements, but often remaining vague at crucial points (e.g. “Add weight to actions”), leaving room for a more structured academic perspective that facilitates further, more detailed analysis of juicy design. Industry presentations focus on ways of implementing "*juicy features*" such as *adding screen shake* [102] or *googly eyes* [75], but only deal superficially with the effects of juiciness on player experience.

This is also reflected in game post-mortems again focusing on the implementation of juiciness rather than the effects it has on players, e.g. [91].

The concept of game feel frequently emerges in discourse on juiciness, suggesting that juicy design can contribute to good game feel [142]. According to Swink, positive game feel is associated with seven aspects: (1) Predictable results that allow a sense of mastery and control by correctly and consistently interpreting player input. (2) Novelty that engages the player over time. (3) Good feedback enabling mastery, control, and learning by rewarding player experimentation. (4) A low skill floor, high skill ceiling should be present to maintain short- and long-term engagement. (5) Actions should have context that facilitates meaningful game mechanics. (6) Impact and satisfying resolution which defines the weight and size of objects through their interaction with each other and the environment. (7) Appealing reaction producing appealing reaction regardless of context or input [142]. Some of these elements share characteristics with the current definition of juiciness: for example, predictable results are fostered through abundant feedback to actions that makes an action chain easy to understand; additionally, juicy feedback contributes to creation of weight and impact in objects and actions. Outside the context of games researchers have explored concepts around creating a positive interaction experience that feels good for example Norman proposed three layers of interaction aesthetics [103]. These layers are Visceral, Behavioural, and Reflective emotions [103, 104]. Visceral emotions are seen as the lowest level of emotion and consist of quick judgements that govern if the experience was good or bad, safe or dangerous. Behavioural regards the experience as they happen, is it pleasurable and effective? Reflective Emotion is the feeling of self-image and satisfaction that a player feels when recalling an experience.

2.2.2 Juiciness vs. Feedback in Games

An area that is inherently linked to the idea of juicy design is the element of feedback in games, i.e. the information that the player receives about their input, and changes in game state. Feedback can be audio, visual, haptic, or a combination thereof; feedback elements are important to improve player experience [43].The importance

of feedback to player actions has also been linked to a key attribute for successful games [124]. The role of feedback in games has been well researched, e.g., [29, 31, 70], and existing research demonstrates that feedback can lead to improved performance [85]. Additionally, the timing of when the feedback is displayed to the player has an effect on how they perceive the feedback and changes the overall experience [20].

Beyond establishing that feedback to player actions is established a crucial element of successful games [120], existing work has explored how variances in feedback affect player performance and experience. For example, in an exergaming setting Lamoth [85] found that participants performed better when given explicit visual feedback on performance, looking at educational games Erhel [38] found that regular performance feedback increases learning, and in the context of persuasive games feedback play s a vital role in facilitating behaviour change [7]. While feedback as a concept is well understood, little research exists that explores the effects individual aspects of feedback can have, e.g. vibration feedback where there was none in the context of games, although this is well understood by the broader HCI community, e.g. [65]. Jarvinen explored the different visual styles present in games and how these audiovisual elements work breaking down the styles into different categories such as *soundscape* and *visual outlook* [73]. Anderson and Casey highlight the importance sounds in establishing immersive virtual worlds[2]. Jørgensen also found that players have a large reliance on audio feedback cues in order to effectively play games [76]. While audio has received attention through empirical studies, visual feedback elements remain largely understudied in their potential effects on player experience.

Numerous lenses, frameworks, and heuristics exist that seek to categorise and explain the nature of feedback in games. For example, Schell proposed several lenses that address the nature and design of feedback in games [133]. The Lens of Feedback raises questions about how feedback on the game state is delivered to the player, e.g., "What do players need to know at this moment?" [133]. The lens also focuses on what the player should feel at any given moment, challenging designers to consider what feedback will help elicit the intended feelings. Further addressing the nature of feedback, Deterding presented design lenses that detail different characteristics of feedback to elicit a positive player experience, e.g., surprising, immediate and varied

[31]. Among others, Dersurvire's PLAY heuristics contain a category devoted to the nature of feedback, proposing a focus on consistent and immediate feedback to player actions while also highlighting that feedback should be simultaneously delivered on different feedback channels, e.g. audiovisual [30].

In the context of juiciness, it is therefore important to highlight that it provides *implementation advice* for feedback (e.g., high-level recommendations such as "make it juicy" [75]); differences between juicy and non-juicy games should therefore focus on *how* feedback is presented and the *frequency*, with juicy games conveying the same kind of information to players as non-juicy counterparts.

Juiciness as a concept has existed in the industry since at least 2006 and has continued to gain traction as a design term for creating satisfying experiences. While it's industry usage highlights it's potential usefulness existing definitions from designers are lacking in depth, existing only to give factual examples of elements of juiciness rather than explaining the high level concept. Meanwhile academia has begun to explore and take an interest in juiciness for it's potential to improve the player experience although little work has evaluated it's effects currently and those that have not used an empirically derived version of juiciness. There is a clear need for a deeper understanding of the both the concept of juiciness and it's effect on the player experience.

2.3 Player Experience

In this section an overview of the player experience (PX) is presented to frame what aspects of the experience juiciness can effect. This is done through conceptualising PX followed by a detailed breakdown of SDT as previous literature has pointed to many aspects of juiciness conveying qualities that would foster intrinsic motivation in the context of SDT.

PX is a broad term that refers to a player's emotions and opinions that they form when playing a game, a game experience is a multi-dimensional experience and thus can be measured through quantitative and qualitative means [100]. PX is largely

concerned with how the player feels while interacting with the game, where as the field of playability looks at evaluating the design of a game [100], while juiciness may have an affect on both of these aspects the literature has mainly centred around PX [78, 79]. PX has been a focus of games researchers with multiple methodologies and approaches being applied from other fields to allow for ways of empirically measuring aspects of the experience [94]. Pagulayan et al report successful ways of operationalising PX through applying existing HCI methods and interaction design evaluation tools and applying them to games, for example using experience surveys for short experiences, and group discussions for deeper experiences reflections over a longer period of time [107]. A wide variety of approaches have found to be successful in gaining an insight into how design effects PX for example Poel et al found using structured focus groups worked well [113], success has been found with using biometrics to measure PX through looking at arousal measures or reaction to ingame events [119]. Experience surveys have also seen widespread use when looking to measure aspects of the PX with a multitude of questionnaires available depending on what facet of the experience you are looking to measure [25], for example exploring feelings of competence in motion games with older adults [138]. Lastly games researchers have also used player metrics as a way of inferring facets of the player experience from objective things such as high scores [82] or engagement metrics [107]. Collecting player metrics allow for in-depth data (timestamps, performance) to be collected and analysed to understand the PX, because of this pull the game industry also makes heavy use of metrics in addition to supplementary data from questionnaire responses (among other sources) to help craft better player experiences [28, 114]. More recently, PX research has linked engaging experiences with the fulfilment of players' psychological needs (e.g., [129]). Most prominently, SDT [24, 126] has been used as a measure of intrinsic motivation, which is fostered through satisfying human needs for competence, relatedness, and autonomy.

2.3.1 Self-Determination Theory

A common theme among the work presented throughout this chapter is the concepts of player autonomy and control, concepts that fit into SDT, a theory of human motivation well-being [128]. The basic assumption of SDT is that peoples motivation to grow and change is governed by three innate and universal psychological needs [126, 24]. For example children have been found to perform better in school when their universal psychological needs are met [126]. It builds on several sub theories that will be discussed here. The first of these sub-theories is **Needs Satisfaction** a theory that defines three core human needs that need to be satisfied to foster high quality intrinsic motivation, autonomy, competence, and relatedness [126, 128]. Autonomy, refers to freedom from external control and experiencing sense of independence in a task [127]. Competence is the sense of being in control and having mastery over the situation [127]. Lastly, a main concept is relatedness which is based on the human need to belong [10, 127], and humans being able to feel connected during a task. When the needs of a human as defined by SDT are met, the theory assumes that humans have volitional and high quality motivation, which leads to enhanced performance, creativity and learning in a task [129]. A key component of SDT is that when the individual needs for autonomy, competence, and relatedness are met, they will thrive and also experience high quality well-being, as *"there actions reflect the truest values of the self"* [127]. The second sub theory of SDT is **motivation**, which details the energy to complete an action that a human has when undertaking said action, and the direction that the energy is aimed in, e.g., at the task or at avoiding the task [126]. This theory of motivation consists of three different types of motivation, the first that has been previously mentioned in this chapter is intrinsic motivation. Intrinsic motivation is when a task or activity is pursued purely for the joy of engaging with the task, e.g., engaging in a hobby such as playing video games. The other type of motivation in the context of SDT is extrinsic motivation. Extrinsic motivation is where an external reward is present, and the task is completed with the reward in mind (rather than for the sake of engaging with it). Lastly, there is **Amotivation**, where the human has no motivation for the task at hand and does

not know why they are still completing it [126]. These three motivations and the concept of satisfying basic human needs are largely what constitutes SDT [126]. SDT is grounded in scientific theory, with most factors being able to be empirically tested [153], i.e., a persons feelings of competence is able to be measured by numerous questionnaires such as the intrinsic motivation inventory [95]. SDT has been well tested as a method for evaluating a person's motivations for subjects like sports and learning [47]. It has also been successfully applied to investigating the motivations behind playing video games [129], which will be discussed in the following section.

2.3.2 SDT and Games

SDT has become a popular theory in the games research community as a way of understanding humant motivations for play and identifying what aspects of games players enjoy [129]. Since Ryan et al. presented an intial series of studies on player expeicne using SDT it has been applied by a large amount of researchers [98].

Research has found that players have a more positive experience in the games when their needs for autonomy, relatedness, and competence are met by the game [116]. Using the needs satisfaction dimension of SDT has been found to be successful as a predictor for a players enjoyment of a game [111]. Neys found through a large scale survey that when a players needs of enjoyment and a sense of connectedness are met, that they are more persistent in playing and not giving in to challenges of a game [101]. Particularly through the Player Experience and Need Satisfaction (PENS) Questionnaire, SDT is a pervasive in many games research projects [98]. The questionnaire consits of five dimensions related to the different facets of SDT, e.g., competence [129]. For example, Hicks et al. used SDT as a way of understanding how players reacted to twitter integration in games using the needs satisfactions to guide design of future work [62], further exploring the sense of relatedness in online games and how that motivates people to play [61]. SDT has also seen widespread use in a varying amount of gaming contexts from measuring the effect on PX that skill balancing in exergames can have [50], to how the speed of character progression can effect player well being [53]. More recently Mekler and Tyack presented an overview

of the usage of SDT across the field of games research focusing on publications at the venues of CHI and CHI Play finding that a large amount of games research makes use of SDT in some way, but that integration often remains shallow and typically falls short of exploring all aspects of the motivation model [98].

Interestingly, some of the academic work on juiciness alludes to elements of SDT, such as the importance of perceived competence facilitated by feedback elements[142]. Likewise, Deterding [32] highlights the importance of designing to facilitate autonomy. A key assumption of the proponents of juicy design is that it can improve player experience. More recently, PX research has linked engaging experiences with the fulfilment of players' psychological needs (e.g., [129]). When looking at the previous work around game feel and juiciness these themes of providing ample feedback to the player and sensations like Swinks control sensation [142]. Therefore this project hypothesise that through adding *juiciness* to a game will increase the player's satisfaction of needs and foster high quality intrinsic motivation. This project will explore how juiciness can impact the overal PX through the lens of SDT.

2.4 Conclusion

This thesis explores juiciness through several steps, as this literature review has summarised juiciness as it is currently understood is intangible and fluffy in it's description with no one empirical definition. This thesis addresses the intangible nature of juicy design by exploring its relationship with feedback through an online survey that incorporates game developers' perspectives on juiciness and game feel. Drawing from their responses, we derive a framework of juicy design that offers a refined perspective on juiciness, and can be applied by researchers and designers wishing to analyse this feature of games. The second issue that is present in this literature review is our current understanding of the effects that juiciness can have on needs satisfaction and how it can potentially help to foster intrinsic motivation. This thesis also addresses this issue through a series of user-studies that explore juiciness in a variety of different genres and scenarios under the framing of SDT.

Chapter 3

Defining Juiciness

Related Publication: K. Hicks, P. Dickinson, J. Holopainen and K. Gerling, 'Good Game Feel: An Empirically Grounded Framework for Juicy Design', Proceedings of the 2018 DiGRA Conference, 2018.

This chapter tackles the intangible nature of juicy design by exploring its relationship with feedback through an online survey that incorporates game developers'perspectives on juiciness and game feel. This issue is addressed through a combination of industry perspectives and academic analysis to provide a more detailed understanding of contributors to juicy design. presented is the creation and results of an online survey on juicy design and game feel that received responses from 17 game developers. These responses are then analysed through the creation of an affinity diagram from which a framework is derived that facilitates the analysis of juicy design rooted in developers' perspectives. Lastly this framework is further refined through application to two examples of commercially available games commonly considered juicy, the casual game *Candy Crush Saga* , and downwell a small independent game. This chapter provides a tangible perspective on juiciness in games, and contributes a tool for the academic analysis of juicy design that makes the concept actionable for researchers and designers. Lastly this chapter discusses implications of developers' perspectives on juicy design and reflects upon the idea of juiciness and good game feel from an academic perspective.

This work presented in this chapter makes the following two main contributions: (1) provides the first empirically grounded tangible definition of juicy design and (2)

presents the creation and validation of the juicy framework tool for analysis of juicy design.

3.1 Related Work

Juicy design refers to the idea that large amounts of audiovisual feedback contribute to a positive player experience [46, 75], and there is anecdotal evidence that some of its elements can contribute to positive player experience and continued engagement [49, 150]. However, while the concept is popular in academic game design communities (e.g.,[31, 133]) and frequently referred to by industry representatives as a means of creating engaging experiences (e.g., [75]: "*[..]the juicier your game is, the more fun it will be to play*"), definitions remain vague (e.g., juicy design needing to evoke a 'visceral' feeling in the player; [18]), and design advice suggests that developers need to have an intuitive understanding of what constitutes juicy feedback (e.g., [30]: "Is there a material or creature whose sensual properties might inspire your feedback?"). Therefore, it remains difficult to understand which elements of a game contribute to juiciness, and how exactly feedback needs to be constructed to be perceived as juicy, with a first exploratory academic study by Juul and Begy [78] returning null results when comparing a 'juicy' and 'non-juicy' tile matching game.

3.2 Questionnaire Design

The questionnaire was designed to explore how developers understand and design for game feel and juiciness, with two separate elements of the questionnaire addressing each of these topics. This section details the design and rationale for the questionnaire structure. For a full version of the questionnaire please see Appendix Item 1.

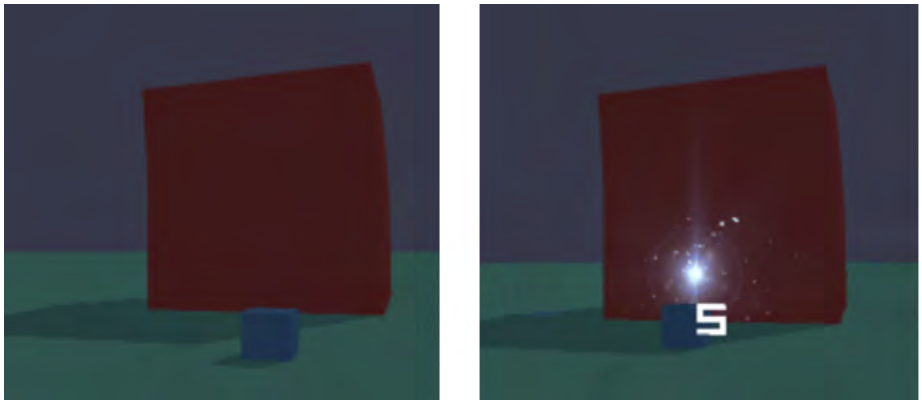

Figure 3.1: On the left is a cube attacking another cube with no effects. On the right is the same attacking cube but with several juicy effects.

3.2.1 Juiciness

This section of the questionnaire asked respondents about their understanding of juiciness, and what effect they felt it had on player experience. To support game developers previously not familiar with the idea of juicy design, they were provided with definitions of juicy effects derived from industry talks [102] and a short description of juiciness based on Juul's work [77].

Here is the definition that was provided to participants: *"Juiciness refers to appealing feedback both visually and audibly that responds to player actions, where a small amount of input can yield a large amount of feedback. A game with lots of juicy feedback will be satisfying to interact with."*

Alongside the definition two animated GIFs that visualised a cube character attacking another cube without and with juicy effects 3.1. Following this definition respondents were then asked what impact juiciness had on the player experience. Respondents were then asked to name a game that they considered to be juicy, and detail what contributed to the games juiciness. Additionally respondents were also asked to provide juicy visual and audio elements as a means of gathering what aspects developers considered juicy.

3.2.2 Game Feel

This section of the questionnaire was devoted to exploring developers' perspectives of game feel. Similar to juiciness, respondents were asked to give their own definition of game feel and then prompted for game mechanics and elements that they thought fostered a positive and/or negative game feel. Additionally, respondents were asked to give examples of games they considered to provide positive game feel and what aspects of these games contributed to the game feel. Finally respondents were asked to name games that did not have good game feel and again what aspects led to negative game feel.

3.3 Data Analysis

Questionnaire responses were very broad while also providing a high level of detail. Because of this the initial analysis of the responses was done through creation of an affinity diagram that allows to organise and connect ideas shared through different responses: Affinity diagrams [67] facilitate categorisation of independent responses into groups that share topics, and have previously been used as a tool for analysis of open ended responses [64].

The initial analysis was carried out jointly by two researchers. First, all responses were broken down into sentences, and each sentence was written down on a post-it note. These notes were displayed for analysis; each note was discussed and given a category based on the idea it represented. Once a few notes were assigned categories, categories were grouped with existing categories that shared themes (see Figure 3.2). New categories were created for notes that did not clearly fit into existing ones. Some notes contained several ideas and were broken down further to represent each thought and then placed in their respective categories. After initial sorting, the categories were refined, resulting affinity diagram by rearranging notes where necessary, and then began to explore potential connections between groups. Lastly the affinity

diagram was finalised with a three-tier structure, the higher tiers relating to more high-level topics. Figure 3.3 provides an overview of the affinity diagram.

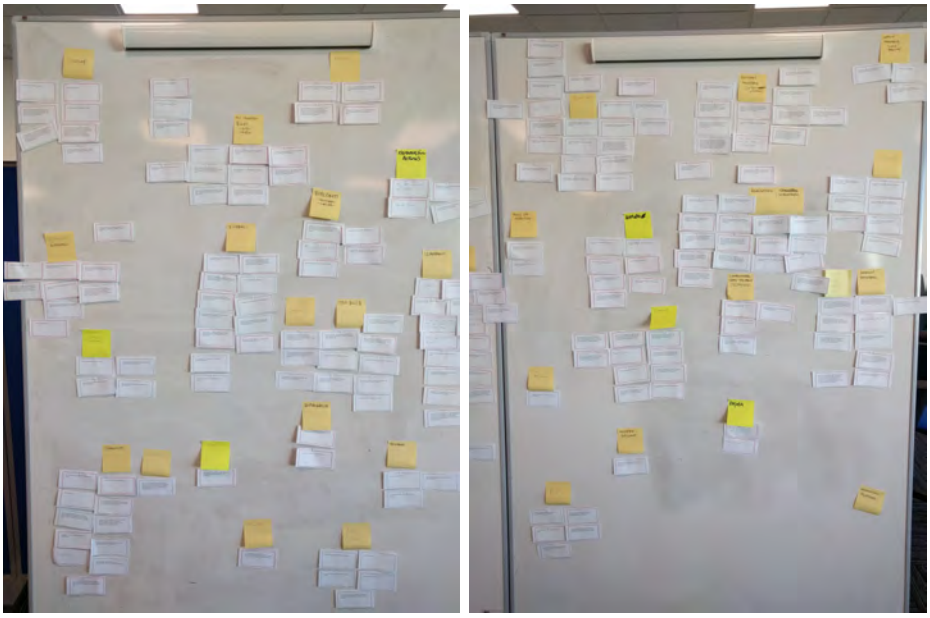

Figure 3.2: Photos of the grouping process while creating the affinity diagram.

3.4 Affinity Diagram Results

The results of the affinity diagram reveal that game concepts and elements that create good feeling games frequently overlap with what designers also consider juicy characteristics. Designers placed emphasis on how juicy design can affect the player experience. Also revealed was the importance of using juiciness to convey the state of the game using different aspects such as ambient and unambiguous feedback. Lastly responses covered the difficult task of making all elements of the game cohesive making actions and feedback complement each other whilst also feeling believable in the game context. This section details each of the categories that emerged from the affinity diagram.

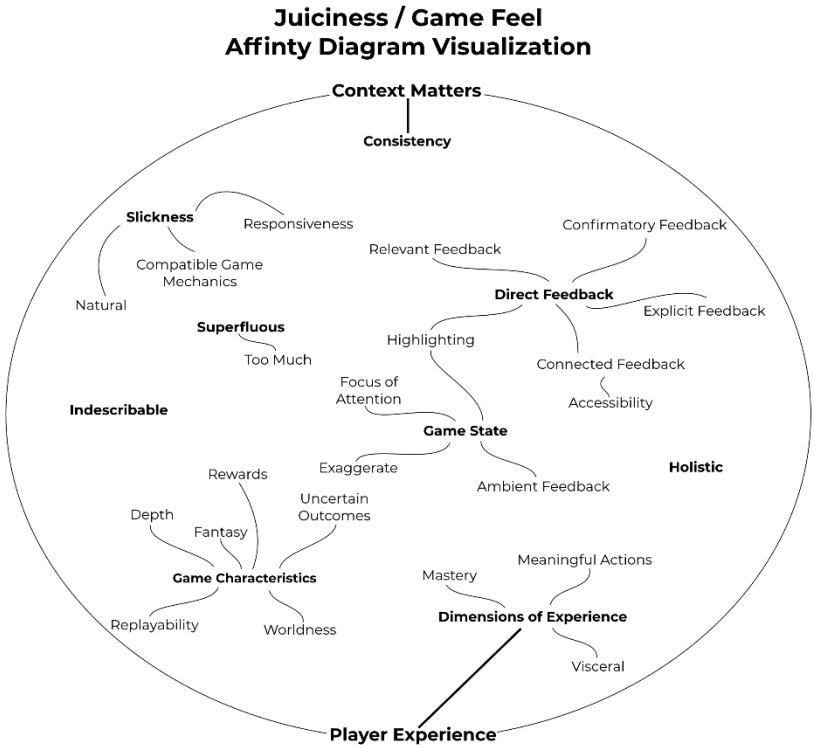

Figure 3.3: An overview of the finalised affinity diagram.

3.4.1 Contextualised Experiences

This (*Tier 1*) overarching category was repeatedly referred to in participant responses, and highlights the importance of integration of all game elements (e.g., core mechanics, feedback, and overall design of the game) into an overall context, including those that would contribute to juiciness and a positive game feel. Participants highlighted the importance of how these elements are used in the context of the genre (e.g. "*the usage also needs to match the game type*"). Depending on the nature of the game, some game elements were considered to have a detrimental effect on game feel (e.g., reflecting the mood of the game), although participants also expressed that some aspects are similar across games. The importance of this category is that it governs all of the other emerging sub-categories in that the integration of all elements of a game into a coherent, contextualised experience is key to consider for designers.

3.4.2 Player Experience

The (*Tier 2*) player experience category summarises how player experience is influenced by different aspects of juicy design, and how player reflection on game content can contribute to a game being perceived as juicy. It includes the sub-categories *Game Characteristics* and *Dimensions of Experience*.

Game Characteristics

This (*Tier 3*) category summarises basic characteristics of game elements (and thereby the resulting game) that developers thought to contribute to a positive player experience (see Table 3.1). For example, developers expressed how game elements need to provide consistent feedback to player actions, and that juiciness (in this case the amount of feedback) should help the player understand their actions, with one respondent stating that *"you should be able to estimate from the juiciness of each action the utility of that action."* This consistency also extends to other game elements, i.e., providing a consistent, believable game world that contributes to a positive player experience. Further emerging from the diagram was the idea that the

Game Characteristics	Features (elements) that contribute to player experience.
Consistency	Game elements need to behave consistently with expectations
Worldness	Consistent game world with elements that foster believability (not necessarily realism)
Replayability	The game includes elements that lend themselves to replayability making the game fun to play multiple times
Rewards	Responses to player actions should foster sense of reward
Uncertain Outcomes	Player actions should have uncertain outcomes outside of the players control when adequate
Learning Curve	Game mechanics should be simple to learn but hard to master

Table 3.1: Overview of the game characteristics most commonly brought up by developers in the context of juicy design and good game feel.

game needs to offer incentives for replayability through either mechanics that lend themselves to repeated interaction, or by supporting different styles of play. This ties into the concept of uncertain outcomes that was present in this category: while the game should be consistent in general, it should also provide the opportunity for uncertain outcomes that induce curiosity and encourage repeat engagement, e.g., random loot in a game such as *Destiny* or *Diablo III* . Other game characteristics that were mentioned by developers as contributors to juicy design include the learning curve, with one developer stating that games need to be *"easy to learn but [have] a high skill ceiling."*

Dimensions of Experience

This (*Tier 3*) category summarises different dimensions of experience that can emerge from play (Table 3.2), i.e., experiences that can be designed for through the interplay of different characteristics that developers thought were integral to good game feel. This includes opportunity for visceral responses that games can trigger through feedback and certain game elements. For example, one respondent suggested that "*speed, power, sex, pain, chaos*" would contribute to such a response. Further, the sense of mastery that a game can provide need to be considered; in this context an

Dimensions of Experience	Emerge through engagement with a game, are designed for
Visceral	The impact of game elements on 'visceral emotions', intuitive and immediate player responses to game content
Fantasy	A game should facilitate achievement of a player's fantasy goals
Mastery	Feelings of mastery and competence should be facilitated through choice of games elements and feedback
Meaningful Actions	Player actions need to be meaningful within game world

Table 3.2: Overview of the dimensions of experience that emerge through play most commonly brought up by developers in the context of juicy design and good game feel.

emphasis was placed on fine tuning and balancing game elements to facilitate this experience. In this context, developers thought that some game elements can contribute to the player not only experiencing mastery but also finding meaning in their actions: Games should provide the player with the possibility of having both meaningful inputs and meaningful choices e.g. "*feedback of the results of player actions is gradual but meaningful.*" However, they did not elaborate how meaningfulness could be communicated. Developers also focuses on the fantasy fulfilment that can be provided, through the pleasurable nature of a games reactions for example crashing a car and seeing the explosive chain reaction.

3.4.3 Game State

This (*Tier 2*) category contains responses that relate to how the current state of the game is communicated to the player through different game elements (see Table 3.3). Most prominently, the provision of exaggerated feedback emerged as a key strategy to effectively communicate changes in game state, with one responding commenting that "*if you're going at max speed the ball deforms slightly.*" However, developers also outlined that "*juice should be used to direct the players attention, not divide it,*" suggesting that it can be a means of focusing players on relevant game elements and needs to be applied to game elements strategically as to not overwhelm the

Game State	The importance of game elements feeding back to the player the state of the game
Exaggerate	To effectively inform the player of the state of the game reactive elements should be exaggerated to more effectively show how the state has changed
Focus of Attention	Feedback elements can be used to direct the player to critical game state information which guides the attention of the player
Highlighting	Feedback elements that highlight game state information are important
Ambient Cues	Considers the importance of feedback that is received by the player without input

Table 3.3: Ways of communicating game state most commonly brought up by developers in the context of juicy design and good game feel.

player. This goes along with the idea of using game elements that highlight other relevant aspects of the game without drawing the full attention of the player. Finally, ambient cues describe a type of feedback that provides subtle cues without explicit input, thereby informing players that the game world is still live even in idle states, e.g., trees swaying in the wind. In this context, developers pointed out that juicy design "*should be about creating useful feedback that naturally tells the player about what's going on.*"

3.4.4 Direct Feedback

This (*Tier 2*) category, in contrast to feedback that is provided to communicate the game state, the concept of direct feedback emerged as a separate category of feedback given in direct response to player actions. Most importantly, confirmatory feedback "*[. . .] to physical actions such as moving a controller or pressing a button*" helps to create a responsive experience; one designer commented that "*when the player presses input to engage the action, the juice makes the action feel impactful and meaningful.*" This relates to the concept of multimodal feedback, where multiple communication channels are chosen to convey information. For example, the player pressing the jump button is accompanied by the sound, visual and, in some cases haptic effects at the same time. Respondents expressed how important it was for feedback to be given to

Direct Feedback	The differing types of direct feedback that the player receives
Confirmatory Feedback	Direct reaction to an input from the player which contributes to the game feeling good
Multimodal Feedback	Multiple feedback elements are present for any one thing at a point in time
Relevant Feedback	Feedback elements are relevant in the context of the action the player has performed
Explicit Feedback	Feedback should exist that is explicit in nature and requires no interpretation of meaning
Feedback to Improve Accessibility	Extra feedback can improve the accessibility through making game information understandable when missing feedback elements

Table 3.4: Categories of direct feedback that developers consider to support juicy design.

the player in multiple ways simultaneously: *"every action that the player can take is accompanied by animation, sound, special effects".* Along these lines, respondents mentioned integration of multimodal feedback as an accessibility feature, e.g., "*hard of hearing players will require strong visual feedback, and sight impaired will require audio feedback."* Further specifying direct feedback, a recurring element was that juicy feedback needs to be relevant in the context of the player's actions, and that it should provide cues to help players understand game mechanics. Likewise, developers discussed the importance of explicit feedback without need for interpretation that is applied in critical situations, as for example implemented through non-diegetic interface elements that provide numerical information on the state of the player.

3.4.5 Superfluous

This (*Tier 2*) category contains respondents comments on the redundant nature of juicy feedback (not referring to just-in-time multimodal feedback), relaying information repeatedly through the same channel (i.e., providing multiple forms of visual feedback on one event). This redundant or perhaps superfluous characteristic of juicy design can be challenging when it overwhelms the player, with one respondent commenting that "*the pleasure aspects should not detract from the others like too much screenshake."* Developers highlighted that abundant overwhelming feedback

Redundancy	Feedback elements that repeatedly convey previously presented information (through same channels)
Overwhelming	Amount of feedback overwhelms the player

Table 3.5: The role of redundancy in the context of juicy design.

has negative implications for player experience, e.g., commenting that "*these aspects can easily get in the way and detract from the game.*"

3.4.6 Holistic Nature

In this (*Tier 3)* category many developers commented along the lines of juicy design alone not making a positive game experience, e.g., "*juice alone isn't enough*", outlining that "*game feel is the feature that emerges from the interaction of all the others*". This underlines the holistic nature of juicy design that was touched upon by previous aspects (e.g., consistency and integration of elements with each other), but also formulates one of the key challenges for developers: it is not enough to 'sprinkle' a game with elements of juicy design; it is something that needs to be approached from a holistic perspective.

3.4.7 Intuitive and Indescribable

This (*Tier 3*) category summarises comments that were made regarding the intuitive and therefore indescribable nature of game feel and juicy design. Respondents highlighted their difficulties when trying to put an intuitive understanding of what constitutes a positive game experience into words, and instead relied on examples they hoped other people could relate to, e.g., one developer stated that "*game feel is like how well you fit into a new pair of shoes*" or, more openly stating the issue, "*I have no fucking clue.*" Developers did however point out that juicy design is instantly recognised by players, suggesting that it does in fact exist as a design approach, but is hard to verbalise.

Slickness	Aspects of the game that contribute to it feeling smooth and silky to play
Responsiveness	The game needs to feel responsive to the players action through immediate reactions through feedback and mechanics
Natural	Game aspects feeling natural in the context of the game world.
Complimentary Game Elements	Game elements working together to be greater than if they were alone

Table 3.6: Elements that contribute to a game being perceived as 'slick'.

3.4.8 Slickness

The (*Tier 3*) category summarises developers' comments that pointed out how juicy design leads to games that feel *"smooth and silky"* to play, which goes hand in hand with fostering positive game feel (see Table 3.6). Factors that contribute to 'slickness' include visual aspects such as smooth animations (e.g., "*animation curves go a long way in creating more pleasant, varied and communicative effects*"), but it can also be as simple as "*smooth movement along the track*." Technical aspects also play a part here with the render rate of the game being attributed to creating feelings of slickness. A further key element that participants raised in this category directly related to responsiveness; e.g., "*our character runs and jumps responsively even when smacking into a wall or leaping off a ledge, and aerial control is very good making it easy and satisfying to pinpoint landings*." Also emerging in this category were how the game elements can feel natural in the context of the game world. This includes how movement in the game should feel real using both "*momentum and friction*". The controls should not feel like a barrier to the player and instead they should disappear in the mind of the player e.g. "*the control is good enough that they disappear [..]*". Lastly some responses also surrounded individual game elements that participants felt created game feel and discussed how certain game elements work well together providing a great benefit e.g. "*I think well-chosen mechanics that work together in an appropriate way and create a whole game experience*." Also arising in this theme was how juicy feedback elements are excellent when they work in tandem with the game mechanics.

3.5 Developing a Framework to Study Juicy Design

This section presents the stages taken to evaluate the framework through its application to two commercially available games. Firstly, the framework is applied by two researchers independently to the game *Candy Crush Saga* ; the framework is then reevaluated and applied to a second game *Downwell* .

3.5.1 Initial Framework

Building on the affinity diagram, this section presents the creation of a framework for game analysis derived from the affinity diagram. This was done by two researchers from a games design background. The method involved exploring the second and third tier categories of the affinity diagram and deriving questions based on the category. For example for the *consistency* category, details of how a game should respond consistently to player actions. The question derived from this was, "*Do the actions of the player translate into feedback the player expects to see.*" The framework comprises five main components (Game Characteristics, Direct Feedback, Game State, Dimensions of Experience, Slickness) that do not have to be followed linearly for game analysis. Each of the components contains several contributing factors that are operationalised through questions that can be asked during analysis.

Table 3.7 gives an overview of the initial version of the framework.

3.5.2 Refinement Through Analysis - Candy Crush Saga

To evaluate the initial version of the framework, it was applied to the commercially available game *Candy Crush Saga* in the first step (available at www.king.com/candycrush). *Candy Crush Saga* was frequently named as a 'juicy' game by the respondents; *Candy Crush Saga* is a match-three puzzle game where the player is challenged to complete levels by matching sweets in groups of three or more by swapping sweets positions to achieve a match of three or more sweets that share the same appearance. The level is complete when a sufficient amount of sweets have been matched or a

Game Juiciness
A. Game Characteristics
A1. Consistency: Do the actions of the player translate into feedback the player expects to see?
A2. World-ness: Are the world and its reactions to player events believable in the context of the game?
A3. Replayability: Does the game cater to different styles of play or feature mechanics that encourage repeated engagement?
A4. Rewards: Are the mechanics and feedback elements rewarding in nature?
A5. Depth: Are the mechanics of the game easy to grasp but hard to master?
B. Direct Feedback
B1. Confirmatory Feedback: Does the game give a direct response to physical input (e.g., button press)?
B2. Multimodal Feedback: Is feedback for one action simultaneously presented through multiple channels at (e.g., visual, audio, haptic)?
B3. Relevant Feedback: When the player receives feedback, is it relevant to the action they have performed?
B4. Explicit Feedback: Is game critical information relayed explicitly?
B5. Accessible: Are feedback elements designed with accessibility in mind, e.g., do they use multiple channels?
B6. Overwhelming: Does the game overwhelm or distract by offering too much game information?
C. Slickness
C1. Responsiveness: Is the game responsive to player inputs for game and UI control?
C2. Natural: Do the game elements feel natural and straightforward to engage with?
C3. Complimentary Game Mechanics/Elements: Are the mechanics suited to each other?
D. Dimensions of Experience
D1. Fantasy: Does the game support opportunities that cannot safely be explored in real life, e.g., crashing a car?
D2. Visceral: Are the actions in the game 'meaty' and evoke a visceral feeling?
D3. Mastery: Are you rewarded through persistence and growth?
D4. Meaningful Actions: Are actions meaningful to the player (e.g., through consequences within the game)?
E. Game State
E1. Exaggerate: Are reactive elements exaggerated to detail state change?
E2. Focus of Attention: Does the game feature feedback elements that draw your attention?
E3. Highlighting: Are feedback elements that highlight information in harmony with other systems?
E4. Ambient Feedback: Is there feedback about the state of the world that is available without explicit player input?

Table 3.7: Presented is the first version of the framework derived from the affinity diagram

score threshold has been broken. The game features lots of "juicy" feedback with cascading audio and visual feedback showering the player when they successfully match three sweets. Additionally the game features multi-modal feedback for any player driven event effectively communicating the state of the game to the player.

Analysis and Refinement Process

Two researchers with a background in game design applied the initial version of the framework to *Candy Crush Saga* independently. Each researcher played the game for around 30 minutes and then addressed each of the questions posed by the framework in a couple of sentences. For example, for the question "*Is there ambient feedback displayed without input?*", one of the researchers answered, "*Yes. The game has one particularly nice ambient feedback element through player inaction, if taking more than a few seconds to choose the game highlights and pulses a potential next moved for the player to make.*" Once the initial note-taking process was finished, both researchers met to discuss the results of their analysis of *Candy Crush Saga*

with the goal of (1) achieving a focus on the contribution of elements of the initial framework to the analysis of juiciness, (2) refining vague elements that were not directly actionable, and (3) the removal of elements no longer relevant. The discussion was structured as follows: both researchers compared their notes on each of the aspects of the framework and ranked them based on relevance in the context of juicy design. Further, researchers explored whether elements were directly actionable (i.e., contained a tangible description rather than wording that left room for interpretation), and tried to either refine these elements, or marked them for removal from the framework. Finally, the researchers revisited the initial framework, added refined elements, and removed unclear / irrelevant elements.

(1) Identification of highly relevant elements. Some elements of the framework were revealed to be highly relevant for analysing 'juiciness', for example questions exploring how the game state is conveyed to the player or questions on the exaggeration of elements highlighted elements that *Candy Crush Saga* uses to convey important aspects to the player. The game characteristics were also relevant, further revealing how complimentary mechanics and systems make *Candy Crush Saga* feel juicy. Additionally, questions surrounding direct feedback mechanics granted insight into the differing types of feedback elements used to foster a 'juicy' feeling.

(2) Refinement of elements. Throughout discussion, some difficulty in interpreting terminology and questions was revealed. Therefore, several parts of the framework were refined to use more precise language: For example, 'meaningful' actions were changed to 'actions impactful in the game world', and 'World-ness' was changed to thematic coherence to better reflect the nature of the accompanying question.

(3) Removal of elements. Several sections of the framework were removed as application to Candy Crush Saga revealed that they were either too vague (and could not be specified), or too broad and therefore not relevant in the context of juicy design (e.g., containing general game design advice). Table 3.8 provides an overview of these elements along with brief justification for removal.

Element	Justification
Slickness	Questions did not reveal anything about juiciness in the game as they were too high level.
Replayability	Too open-ended and targeted high-level design choices that are not relevant.
Rewards	Other questions cover the rewarding nature of the feedback elements which made this redundant.
Depth	Not related to juiciness.
Responsivenss	Redundant as responses were the same as the confirmatory input section.
Natural	Answers were vague to the ambiguous terminology.
Dimensions of Experience	The category was removed as the questions were better suited to other game aspects.
Fantasy	The question was vague and hard to interpret while not providing relevant answers.
Mastery	The answers from this question focused on feedback rather than mastery.

Table 3.8: Elements of the initial framework that were removed after the analysis of *Candy Crush Saga*

Revised Version of the Framework

Table 3.9 presents the second iteration of the juicy framework. Included are the changes resulting from the analysis of *Candy Crush Saga* .

Game Juiciness
A. Game Characteristics
A1. Mechanic: Do the actions of the player translate into feedback the player expects to see?
A2. Thematic: Is the world and reactions to events believable in the context of the game world?
A3. Complementary Game Elements: Are the mechanics compatible with each other?
A4. Visceral: Are the actions in the game 'meaty' and evoke a visceral feeling?
A5. Impactful Actions: Do player actions make a tangible impact on the game?
B. Game State
B1. Exaggerate: Are reactive elements exaggerated to detail state change?
B2. Focus of Attention: Does the game feature feedback elements that draw your attention?
B3. Highlighting: Are feedback elements that highlight information in harmony with other systems?
B4. Ambient Feedback: Is there feedback about the state of the world that is available without explicit player input?
C. Direct Feedback
C1. Confirmatory Feedback: Does the game give a direct response to physical input (e.g., button press)?
C2. Multimodal Feedback: Is feedback for one action simultaneously presented through multiple channels at (e.g., visual, audio, haptic)?
C3. Relevant Feedback: When the player receives feedback, is it relevant to the action they have performed?
C4. Explicit Feedback: Is game critical information relayed explicitly?

Table 3.9: Presented is the revised framework built from the analysis of *Candy Crush Saga*

3.5.3 Refinement Through Analysis - Downwell

To further refine the framework, the revised version was applied to the commercially available game *Downwell* (available at www.downwellgame.com). *Downwell* was named several times by respondents as a juicy game; *Downwell* is a 2D action platformer in which the player controls a character with the goal of reaching the bottom of the well. The player can move left and right, and has ability to jump and shoot (controlled by the same button). *Downwell* has a simplified art style and colour scheme which allows the game to easily draw the attention of the player though the reserved use of colour. All player actions lead to immediate visual and auditory response, e.g., jumping is accompanied by an impulse visual effect, an animation change for the avatar, and two sounds for initial jumping and landing.

Analysis and Refinement Process

Four researchers with a background in game design independently applied the second version of the framework to *Downwell* . Each researcher played the game for around 30 minutes and then addressed each of the questions posed by the framework in a couple of sentences. For example, for the question "Are reactive elements exaggerated to detail state change?", one of the researchers answered, "*The weapon discharge recoil is highly exaggerated to emphasise the power of the action; the level of exaggeration in weapon discharge effects in rapid succession can overwhelm the player.*" Once the initial note-taking process was finished, the researchers discussed analysis results of *Downwell* with the goal of (1) refinement of vague or difficult to interpret elements and (2) removing any elements that were not directly actionable or required the designer to assume knowledge of the player. The discussion was structured as follows: researchers' notes on each of the aspects of the framework were compared, and discussed to examine whether they were unambiguous and actionable whilst still relevant to juiciness. Elements were then refined or removed from the framework.

(1) Refinement of vague elements. Questions regarding complimentary game mechanics and thematic elements were a source of ambiguity in the analysis resulting

Game Juiciness
A. Game Characteristics
A1. Mechanic: Do actions translate into feedback that is expected?
A2. Thematic Coherence: Are the world and reactions to events believable in the context of the game?
A3. Gameplay Coherence: Are the mechanics compatible with each other?
A4. Feedback Coherence: Does feedback reflect the importance of the event?
B. Game State
B1. Exaggerate: Are reactive elements exaggerated to detail state change?
B2. Focus of Attention: Does the game feature feedback elements that draw your attention?
B3. Highlighting: Are feedback elements that highlight information in harmony with other systems?
B4. Ambient Feedback: Is there feedback about the state of the world that is available without explicit player input, making the world appear real and interactive?
C. Direct Feedback
C1. Confirmatory Feedback: Does the game give a direct response to physical input of a button?
C2. Multimodal Feedback: Is feedback for one action simultaneously presented through multiple channels at (e.g., visual, audio, haptic)?
C3. Unambiguous: Can information be connected to actions and only interpreted in one way?
C4.A Relevant: Is feedback giving in response to game critical events or is feedback received on minor player actions that require no further action?
C4.B Supplementary Feedback: Does the game offer subtle additional feedback to emphasise actions already communicated in other ways, or minor player actions (without overlaps with C4.A)?

Table 3.10: Presented is the finalised version of the framework built from the analysis of *Downwell*

into 'coherence of the game world and mechanics'. The question of ambient feedback was also refined; through analysis it emerged that ambient feedback contained several aspects that could be missed as the initial terminology was too vague. The question on the delivery of explicit feedback was rephrased to unambiguous feedback. Lastly, the question on relevance of feedback was tweaked as during discussions revealed that the idea of 'relevance' needed further clarification.

(2) Removing non-actionable elements. A reoccurring issue that researchers came across during analysis was the intangible nature of the questions concerning 'visceral' and 'impactful' feedback. While the concept of visceral feedback is unambiguous, the provision of a tangible definition prove to be difficult; likewise, whether feedback is 'impactful' is eventually determined by the player. However, discussion revealed that both categories could in part be described by more tangible constructs: feedback coherence (i.e., whether feedback is appropriate considering the nature and importance of the preceding player action), and the idea of supplementary feedback that emphasises certain elements of the game.

3.6 Refined Juicy Framework

Presented in this section is the refined version of the framework for analysis of juiciness in games(3.10). It features three main components (Game Characteristics, Game State, and Direct Feedback); each of these components contains several factors that can be populated through asking tangible questions provided as part of the framework.

3.7 Juicy Definition

Based on the results of the study and the validation of the juicy framework the following definition of juiciness is proposed: *Juiciness is a term that describes a game experience that contains a coherent design of game mechanics and visuals, while providing feedback to the player with both direct feedback that is confirmatory, relevant and explicit, but also offering superfluous feedback that helps to inform players about the game state, and contribute to the game being perceived as a coherent whole.*

The key component of this definition is that it captures how juiciness extends beyond just providing superfluous feedback and categorises the type of feedback necessary for a game to feel juicy. This definition also recognises that the non-feedback elements of a game need to be coherent, it is not enough to just add feedback elements to make a game juicy if the underlying experience is not well designed.

3.8 Discussion

This study explores game developers' understanding of game feel and juiciness, and builds on their perspectives to provide a framework for the analysis of juiciness in games. This sections discusses the juicy framework in the context of related work, and provides a high-level reflection on developers' survey responses.

While this study is not the first to consider the benefits of juicy design, it is the first to investigate the concept from a perspective that bridges academia and industry. While previous work predominantly focused on juiciness as a kind of feedback – juicy feedback (See [77, 133, 31]) – the key insight that emerged from the analysis is that developers understand juiciness to be more than just feedback, shifting the focus on the game as a whole.

One aspect that pervaded data analysis and perhaps warrants further discussion is that many game developers seemed to have an intuitive understanding of juicy design, but struggled to put their ideas into words. For example, many responses contained

examples of what would feel juicy (e.g., "*a shoe that fits well*"), and throughout, many similar examples came up (e.g., "*like walking on fresh snow*"). This tendency is interesting for two reasons: first, it suggests that some aspects of games perhaps cannot (or should not) be turned into straightforward advice for analysis and design (similar to other arts), and second, it suggests that there exists a body of inherently pleasant experiences (perhaps linked to shared cultural background) that allows us to communicate intangible experiences (also leveraged by Deterding et al [31]) and that is also relevant in the context of game design.

3.9 Limitations

There are a few limitations that need to be considered when interpreting these results. Most importantly, the study only sampled a small number of developers to allow for in-depth analysis; here it might be worthwhile to follow up with a broader survey to validate the resulting framework. Likewise, the survey included responses from a number of independent developers, whose perspectives may differ from those of developers working at bigger studios. Along these lines, currently only developers' perspectives were examined. Future work should also explore the view that players have on juiciness, and investigate in detail what role visuals and audio play in this context.

3.10 Conclusion

Juicy design and a positive game feel are important goals for designers wishing to create engaging games, however, the concept is difficult to define, and often described in vague terms. To address this issue, this chapter drew from academic work and a survey of industry perspectives, and contributes a framework for analysis that can serve as a tool to make the idea of juiciness actionable for researchers and designers.

Chapter 4

Studying Juiciness

Related Publication: K. Hicks, K. Gerling, P. Dickinson, and V. Vanden Abeele, 'Juicy Game Design: Understanding the Impact of Visual Embellishments on Player Experience', Proceedings of the 2018 Annual Symposium on Computer-Human Interaction in Play, 2019.

The findings in the previous chapter provided an initial exploration into game designers perspectives on juiciness, and presented the creation and validation of the juicy framework. This chapter presents the application of this framework through the implementation of VEs into the design and implementation of two research games. VEs are design elements that do not tie into system functionality, but support information already conveyed by other means [9]. For example, adding an aesthetic theme to a bar graph to engage and highlight key points of information [66]. This is similar to *juiciness*. Regarding the benefits of juiciness, existing work hypothesises that juicy game elements have a positive effect on player experience in general [142], and psychological needs satisfaction in particular, e.g., feelings of competence ("*Excessive, varied sensual positive feedback can instil competence*" [31]) and mastery ("*Juicy feedback is one way of providing experiences of mastery*" [34]).

However, exploratory research has failed to demonstrate a relationship between those elements [49, 78]. This chapter focuses on VEs as one core element of juiciness, through two comprehensive empirical studies to understand their impact on player experience. First presented is the design and creation of regular and juicy versions of two research games: *Frogged Cubed*, a clone of the casual game *Frogger* that has previously been used as a research tool for investigating game visuals [49] and builds

upon a long history of research drawing from implementations of old arcade classics (e.g., [3]), and the first-person action game *Dungeon Descent*. Results of a within-subjects study with 40 participants show that when implemented as VEs, 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. In a follow-up study with 32 participants, the same research protocol was applied through using the commercially available first-person shooter *Quake 3 Arena*, which provides a number of easily adaptable features of juicy design. Results replicate effects of the first study in terms of aesthetic appeal; additionally, juiciness significantly improves perceived player competence, but still does not impact objective performance.

This work presented in this chapter makes the following two main contributions: (1) it provides the first structured study of VEs in games, and their effects on players, and (2) it demonstrates that VEs significantly improve the aesthetic appeal of games, only affect competence in certain settings, and generally have no measurable effect on objective player performance, suggesting that juiciness needs to be studied in a more comprehensive fashion that also takes into account audio feedback.

This chapter is broken down into several sections firstly, the design and implementation of the games is presented, following this are the details of the first study with the two research games (*Frogged Cubed* and *Dungeon Descent*). Lastly, the details for the second study using the commercial game *Quake 3 Arena*, are presented followed by a discussion of the results.

4.1 Research Games Design

In order to study the effects of VEs on player experience, two games were created *Frogged Cubed* and *Dungeon Descent*. Detailed here is the design of the games, the juicy elements that were used, and the validation process that was used for the embellished versions of the games.

4.1.1 Juicy Framework

For the two games that were created for this chapter *Frogged Cubed* and *Dungeon Descent* the framework was used as part of the design process. As previously mentioned in Chapter 3, the framework is an analytical framework and was used in that manner. During the development of both games after the first playable experience was completed, the games were both played with the questions from the framework in mind. After each play session the framework was then applied and used to highlight where areas were missing coherence, directed feedback or game state information. For example, during the development of *Frogged Cubed* after the first version was playable the game was played for 10 minutes after which the framework was applied revealing that the core mechanic of the cube moving felt flat as it did not have any direct feedback, or supplementary feedback. This process was repeated several times throughout the development of both games until it felt like the games were sufficiently juicy, at which point the external game design experts played each game to evaluate the experience (discussed later in this chapter).

Framework Reflection

4.1.2 Frogged Cubed

Frogged Cubed was designed to replicate mechanics from the well-known arcade game *Frogger* . This game was chosen because it has been used in previous related research [49] and for its casual arcade style of gameplay. Additionally, there has been significant research conducted making use of renditions of arcade games [3].

Game Description

The goal of *Frogged Cubed* is to guide five purple cubes across a busy road and river, one by one, and to place each cube on one of the five ending positions. Each ending position can only hold one cube; thus, the player must navigate to the five different points to successfully complete the level. The player must navigate road hazards

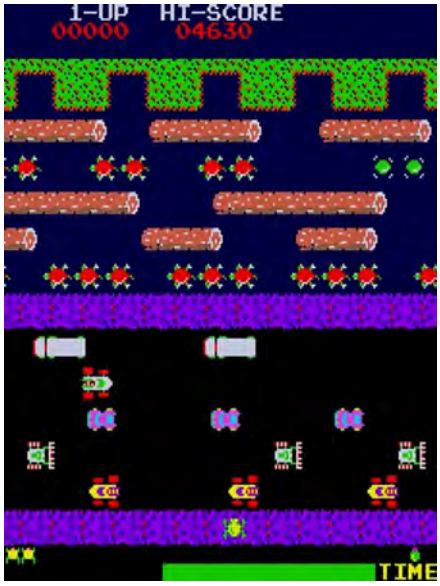

Figure 4.1: A gameplay image taken from *Frogger* .

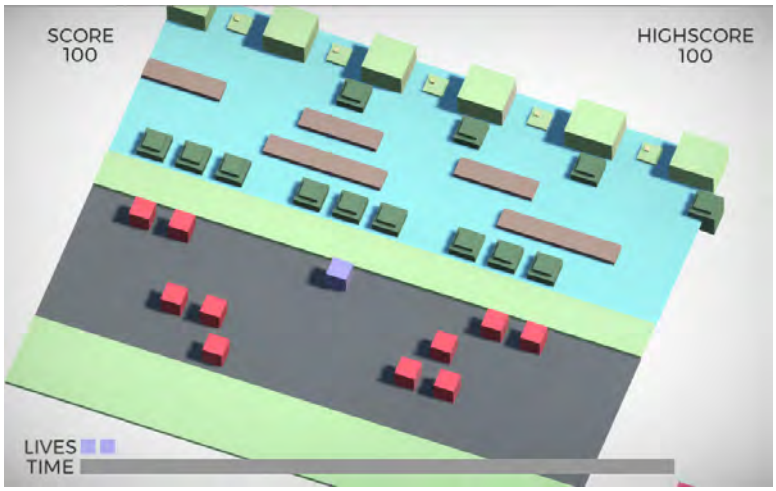

Figure 4.2: A gameplay image taken from *Frogger*

such as cars, and cross the river by moving the cube across moving logs and turtles. The challenge of the game arises from planning paths across and between moving objects, and in timing the required movements. The design of the game closely follows the original *Frogger* game, with the main goal and the hazards being the same. Once players have finished a level, they then progress to the next level which has the same objectives, but will present greater challenge through faster or more abundant hazards. The game uses the arrow keys on the keyboard to move the cube in one of the four directions.

Gameplay

The core gameplay loop of *Frogged Cubed* revolves around the player analysing the current stage and situation, looking at the location of all possible hazards that are on the surrounding tiles. From this analysis the player then decides the action they are going to take e.g. where they are going to progress towards the goal of the level (one of the five goal points). This loop of analysis and action repeats until the player cube reaches the goal of the level and then the process begins again but with the added constraint that the previously reached goal point is now occupied the the player must navigate a different route for the level.

Game Mechanics

All of the mechanics present in *Frogged Cubed* were built based on the original arcade game *Frogger* , all the mechanics work the same functionally to the original in order to stay as true to the original gameplay as possible.

Hazards

Red Cubes. These cubes move along the screen from either left to right or right to left and varying speeds. Depending on the level they can spawn in multiples to provide a larger obstacle to navigate. If the player cube collides with a red cube they will lose a life and be spawned back at the start of the level (completed goal points remain). Added complexity exists with this mechanic arise from having them alternate in directions and varying speeds.

Water. The water exists as a hazard that kills the player if they move into a square that is occupied by water, causing the player to lose a life and progression.

Turtle Cubes. These cubes move across the screen from either left to right or right to left and only exist on the water hazard. The player cube can move onto a turtle cube and use it to crossed water hazards. The player can only stay on the turtle cube whilst it remains in the screen and will be pushed off and killed at the point it

leaves the screen area. Additionally they can spawn in multiples to provide a larger moving platform to cross the water hazard.

Diving Turtle Cubes. These cubes function in the same way as turtle cubes in that the player can use them to progress across the water hazard, however they feature an additional mechanic in that they periodically dive underwater. If they player cube is present on a diving turtle cube when it dives underwater they are killed. This cube has visual indicators for when it is about to dive down to give the player warning to move. Like regular turtle cubes they can also spawn in multiples to provide a larger hazard and moving platform.

Wood Logs. These wooden logs serve as large moving platforms that move in both directions across the screen in the water hazard. They come in three varying sizes which can be used to increase challenge. Much like the other moving obstacles they can also be spawned in multiples to create different paths through the level.

Level Design

Much like the original *Frogger* , all of the levels in *Frogged Cubed* are designed by hand with a gradual learning curve applied to ease the players into the game, as this known to be a key part of the first-time experience [41, 23]. The levels increase in complexity through the inclusion of more hazards and increased speeds of obstacles. This section will now showcase several levels of different difficulties to illustrate this process.

Easy Level. The first level of the game is the easiest as it is designed to firstly teach the player the rules and mechanics of the game and then provide a space for them to experiment. This level (See Figure 4.3) features hazards on every lane of gameplay, however the hazards on this level move very slowly providing the player with ample time to navigate through. The level also introduces every hazard except for the more advanced diving turtle cube.

Medium Level. This is the 8th level of the game (See Figure 4.4), at this point the player is familiar with all the hazards presented and is skilled at navigating across

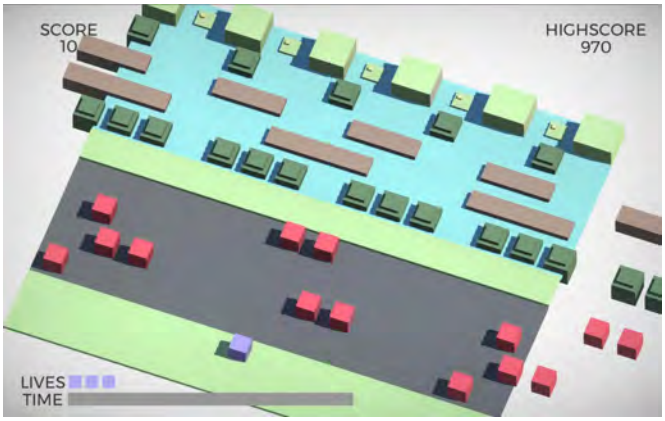

Figure 4.3: A gameplay image taken from the *easy level* of *Frogged Cubed*

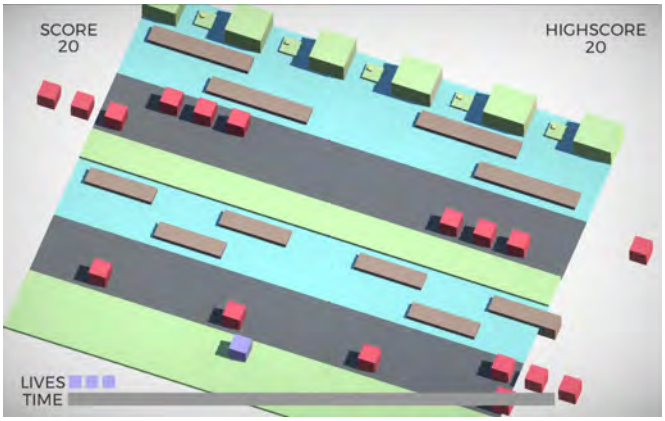

Figure 4.4: A gameplay image taken from the *medium level* of *Frogged Cubed*

the games levels. To add difficulty to the level some hazards move significantly faster than others which creates temporal blockades of hazards that the player must plan around. Most of the difficulty in this level lies in the first half, with the second being more forgiving with plenty of possible paths due to the abundance of obstacles.

Hard Level. This is the 19th level of the game (See Figure 4.5) and one of the most difficult. The player at this point has mastery over the game and now the challenge must be at the apex of what can be done with the games constraints. The hazards in the level appear frequently and moving different speeds; this creates only a few moments where the player can cross safely requiring precise timing. Additionally the second half of this level requires the player to plan how to reach the goal point accounting for the diving turtles again requiring precise timing.

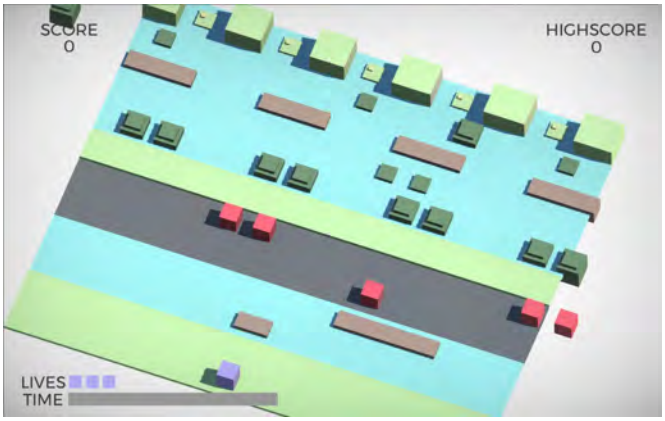

Figure 4.5: A gameplay image taken from the *hard level* of *Frogged Cubed*

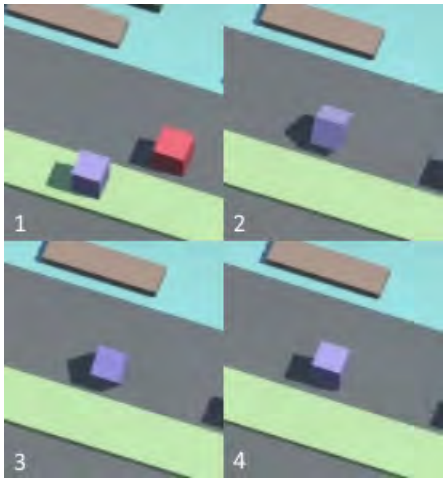

Figure 4.6: Visualised here is the animation that plays when the player cube moves.

Juicy Elements

Drawing from previous work on juiciness [31, 78], several juicy design elements were implemented as visual feedback elements. The elements chosen needed to be suitable for implementation in *Frogged Cubed*, fitting thematically. This section details each of the VEs added.

Movement Animation Effect. In the base version of *Frogged Cubed* when the player cube moves it instantly moves to the next location with no animation, similar to *Frogger* . In the embellished, version the player cube still moves mechanically the same but with a visual animation where the cube rotates upon each movement in the direction of movement. This is visible in Figure 4.6.

Movement Particle Effect. A particle effect was added when the player cube

moves, a small amount of purple dust is emitted as the player cube moves through the level leaving a trail of where they have moved in the environment that persists for several seconds before fading out. See Figure 4.7 for a visual example.

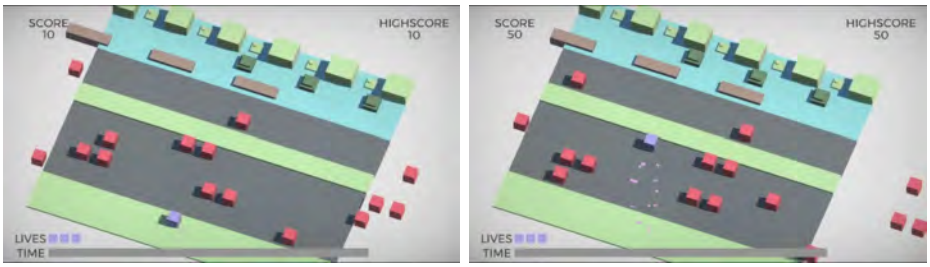

Figure 4.7: **Left** Before the player has moved through the level. **Right** visible are the particle effects that appear from moving.

Collision Animation Effect. In the base version of the game when the player cube collides with a fast moving hazard such as the red cube, the player cube is destroyed on collision and reset at the start position. In the juicy version an animation embellishment was added: when the player cube gets hit by a hazard, they are comically knocked high up into the air and then fall back down at which point they reset. This does not change any mechanics of the game but it does slightly increase the time it takes the player to respawn by a second. See Figure 4.8 for an example of this embellishment.

Music Animation Effect. The game features a upbeat soundtrack in both versions, but in the juicy version all of the hazards and the player cube will bounce along with the beats of the background music track through being visually scaled up and down, reacting to the tempo and volume of the music.

Game Aesthetic

The original *Frogger* makes use of sprites and a top down perspective showcasing the whole level. To stay true to this but to make the game feel more current, a minimalist art style was used and the camera perspective was changed to be isometric, while still maintaining that the whole level is visible at once. This makes the game feel

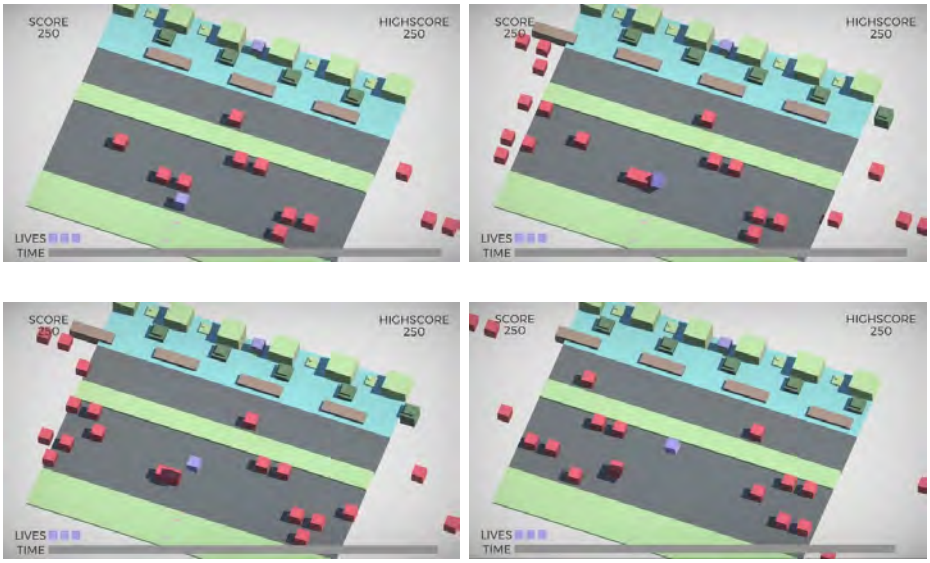

Figure 4.8: This figure shows the frames over the course of one second after the player cube has been hit by a red cube.

more similar to recent adaptations of *Frogger* such as *Crossy Road* , a spiritual successor that was commercially successful recently [136].

Implementation

Design Rationale *Frogged Cubed* was designed and implemented by me, and as such much of my previous experience on developing games has naturally influenced this (See Chapter 1 Positionality Statement). When considering the gameplay loop in this instance the game of *Frogger* was used and copied in a direct manner. Where my design had influence on this though is in the creation of the levels where I used my own understanding of challenge and linear difficulty progression to create the different stages. When considering how to implement the juicy elements that are featured in the game (highlighted as missing by the juicy framework), I explored similar games to see how they were providing juicy feedback and again leveraged my own design experience. For example, when trying to make the movement feel juicy I've previously used rotating animations to add juice to player movement so applied that to this game.

Technical *Frogged Cubed* was created in Unity3D 2018 [144]. All artwork, models, audio, and code were created by the author for this thesis. Models were created using Blender 2.7 [22]. Audio was created using Audacity 2.1.3 [5]. Textures and other miscellaneous art assets were made with Paint.Net 3.8 [35]

4.1.3 Dungeon Descent

Dungeon Descent was designed to provide a more complex game experience when compared to *Frogged Cubed*. The core mechanics of the game consist of first-person melee and ranged combat similar the combat gameplay found in games such as *The Elder Scrolls V: Skyrim* , where the player is tasked with slaying enemies and progressing through floors of a dungeon. *Dungeon Descent* provides a more in-depth and sophisticated 3D game experience, featuring game mechanics that can be combined to produce new outcomes, e.g. players can time the use of their shield to block, counter-attack or knock the enemies back; this can then have different outcomes depending on context of the action.

Game Description

In *Dungeon Descent* the player controls an avatar, and views the world through a first-person perspective. The goal of the game is to traverse through the levels of the dungeon, whilst fighting the enemies contained on each level, in order to progress. Players must avoid taking too much damage or they will go back to the start of the dungeon. *Dungeon Descent* was designed to consist of standard mechanics found in the first-person Shooter (FPS) game genre. The player is able to move their avatar in four directions with the WASD keyboard keys, while the mouse allows the player to look around and steer the direction of movement. The player is able to attack, block, dash and perform a weapon-based special move, at the cost of stamina. The core game mechanics revolve around blocking an enemy attack, and then counter-attacking whilst the enemy is vulnerable. The challenge for the player is in speed and skill of movement and weapon use, and also in selecting appropriate tactical play to avoid taking damage.

Gameplay

The core gameplay loop of *Dungeon Descent* revolves around the player landing on a new floor of the dungeon, traversing this environment looking for enemies and then killing all of the enemies to then progress to the next floor of the dungeon, going deeper and deeper with the difficult scaling up the deeper down the player goes. The second gameplay loop that exists in the game is the combat loop, once the player has found an enemy they must watch the attack pattern to plan when to block or dodge and then when they can counter-attack.

Game Mechanics

The mechanics present in *Dungeon Descent* take inspiration from common mechanics found across the FPS and Action Adventure genres.

Enemies

The game features four distinct enemies with their own mechanics.

Slime. This is the most basic enemy in the game that can come in two variants, *ranged* and *melee*. Both have a small amount of health requiring only 2-3 attacks with the player's starting weapon to be killed. When the player approaches the slime will begin to move towards the player and follow them providing they remain within following distance. This allows the player to escape out of combat with the slime if desired. If the slime is *ranged* it will fire a red projectile at the players location every 3 seconds when in range, which can be blocked or dodged. If the slime is *melee* and the player is within range it will visualise it is about to attack and then slam into the player, this slam can be blocked or dodged. See Figure 4.9.

Blue Slime. The blue slime functions the same as the regular slime with two modes of attack *melee* and *ranged*. However, when a blue slime is killed instead of dying it splits into two smaller blue slimes. Upon these smaller blue slimes dying once again they split into two more slimes (See Figure 4.11 for the final time. Each time the

Figure 4.9: An image of the slime enemy.

Figure 4.10: An image of the Blue Slime enemy.

blue slime splits into smaller ones the total health and damage they deal is reduced. A blue slime will split into a total 6 slimes. See Figure 4.10.

Ghost. The ghost enemy will begin to move towards and follow the player from the moment they land on the dungeon floor. When they are near the player, the player will begin to take constant damage. Ghosts are weak and die in one attack from the player. Additionally if the player looks in the ghosts direction they ghost will stop moving towards the player. See Figure 4.12 and 4.13.

Slammer. This enemy does not follow the player, instead it waits floating up above the ground waiting for the player to be near, at which point it slams down and damages the player if they are close enough to the impact. Due the floating nature of this enemy it is easier to kill when the player is using a ranged weapon as opposed to melee. If the player is using a melee weapon they must lure the slammer down and attack whilst it is grounded. It takes between 3-4 attacks from the basic weapons to kill this enemy. See Figure 4.14.

Figure 4.11: An image of the small blue slimes that spawn when the blue slime is destroyed.

Figure 4.12: An image of the ghost enemy.

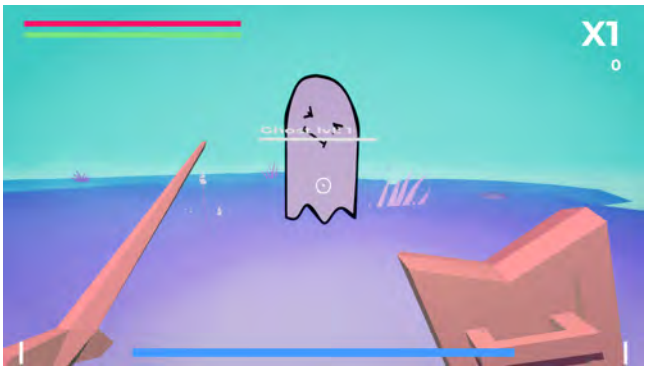

Figure 4.13: An image of the ghost enemy when it has been seen by the player.

Figure 4.14: An image of the slammer enemy.

Character

The player character uses a typical FPS control scheme where the WASD keyboard keys control the movement of the avatar and the mouse is used to control the direction. Left click will attack. Depending on whether the player has the sword weapon or staff weapon (described below) the type of attack will change. Right click will perform a weapon unique move. The player character is able to perform a dash movement skill regardless of weapon choice, which can be used to dodge attacks and move around the environment. Additionally, the player character can also jump through pressing the space button to traverse obstacles, this can be combined with the dash for a long jump. All of these actions (attacking, specials, and dashing) cost stamina to perform. Stamina is a limited resource that fills up naturally over time when not carrying out actions, indicated in game by the green bar. Lastly, the player character also has a fixed amount of health points as indicated by the red bar in game. When taking damage from enemies the player looses health points, if they lose all of their health the game will restart from the first dungeon floor.

Souls

The game also features a collection mechanic through the picking up of souls from defeated enemies. When a enemy is killed they drop several blue shards(souls) that can be picked up by the player. Upon being picked up they will increase the souls bar (at the bottom of the screen), this bar decays naturally over time, if the player

Figure 4.15: Visible is the player performing a shield bash with the melee weapon.

keeps picking up souls in quick succession the bar and fills the bar then the player enters a hyper mode until the bar depletes, during hyper mode the player moves and attacks faster.

Weapons

The are two types of weapons that the player can wield in the game. Weapons spawn in the world as the player progresses and can be picked up in exchange of losing the current equipped weapon.

Melee. The melee weapon is the default start weapon. It is cable of a chain of three attacks through pressing the left mouse button (see Figure 4.15). Whilst wielding a melee weapon the player will also have a shield which can be used to block the damage from attacks by pressing the right mouse button, holding this down keeps the shield raised but drains the players stamina (see Figure 4.16). Successfully blocking attacks also drains stamina limiting the amount of attacks the player can block. Lastly the player can also perform a shield bash as their special action when equipped with the melee weapon (see Figure 4.15). The shield bash costs stamina to perform; when used on an enemy, it will knock them away from the player but causes no damage.

Ranged. The ranged weapon is a staff that functions in a similar manner to any first-person-shooter gun in that holding down the left click will continuously fire a ranged projectile that can be aimed using the reticle to attack enemies (see Figure 4.17,4.18). Because of it's ranged ability, in order to balance this weapon it costs more stamina than the melee weapon and cannot block. Instead of blocking, when

Figure 4.16: Visible is the player blocking.

Figure 4.17: A player wielding the staff.

the right mouse button is pressed the player can charge up a larger projectile that deals more damage at the cost of more stamina (see Figure 4.19). Lastly the ranged weapon can also perform a knock back attack similar to the shield bash that will knock enemies back in a circle around the player (see Figure 4.20).

Figure 4.18: The attack animation for the staff weapon.

Figure 4.19: A player charging up the special attack of the staff.

Figure 4.20: An image that shows the staffs knock back effect in action.

Level Generation

Dungeon Descent makes use of procedural content generation techniques in order to generate the levels that the player explores, after this first island everything that the player encounters has been procedural generated following a set of rules. This approach was taken to again allow for this game to constitute a more complex experience than what is present in *Frogged Cubed*.

The approach taken was to break down the levels of *Dungeon Descent* into floating islands. The first step is to generate the island shape following a height and shape map of a rough circle. Once this is created the island is then populated with holes to server as a hazard. Next, some obstacles and environment clutter is spread around the island to make it feel more immersive. The final step is to populate the island with enemies; this is done through a value list with different enemies having a value assigned to them and adding more enemies until the island's total value is achieved.

After all of these steps the island is finished. See Figure 4.21 for examples of the generation.

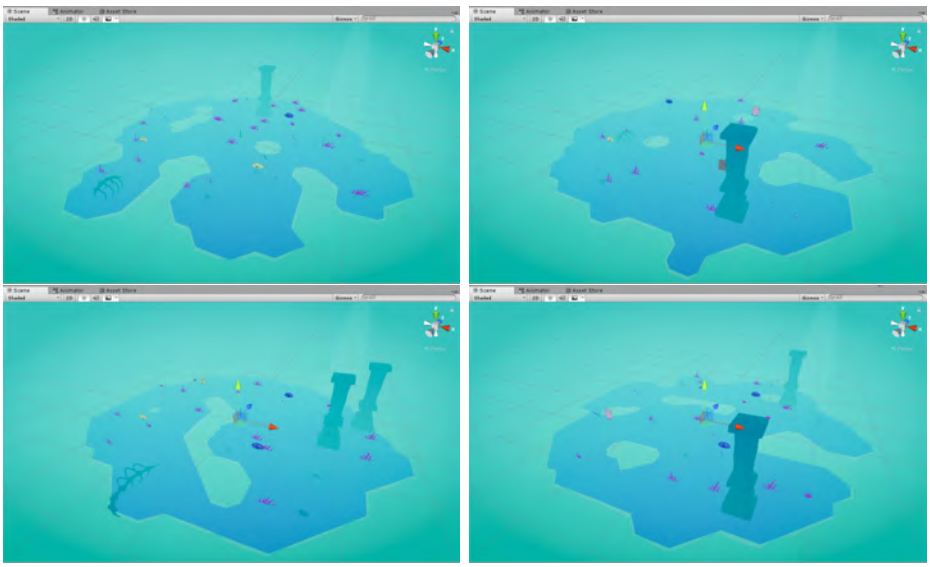

Figure 4.21: The procedural generation of the games levels.

Juicy Elements

Much like *Frogged Cubed*, juicy elements in *Dungeon Descent* were designed using previous work as a guide [31, 78]. The juicy version of *Dungeon Descent* has a number of additional juicy elements all of which are detailed here. Due to the more complex nature of the game, some juicy elements are deemed more significant than others.

Enemy Hit Effects. When the player hits an enemy in the standard version, a small hit effect is displayed as a basic mandatory level of feedback (see Figure 4.22). However, in the juicy version of the game several other effects are layered on top of this one including a particle effect and animation causing the enemy to flash when hit by the player (see Figure 4.23). Additionally, a number appears for explicit feedback on how much damage the player has dealt. Both the base and the juicy versions make use of a health bar for core feedback of the enemies status; in the juicy version the health bar chunks away and falls of when the enemy receives damage (see Figure 4.23).

Figure 4.22: Displayed is an enemy that has been hit in the base version of the game.

Figure 4.23: Displayed is an enemy that has been hit in the juicy version of the game showcasing the added effects.

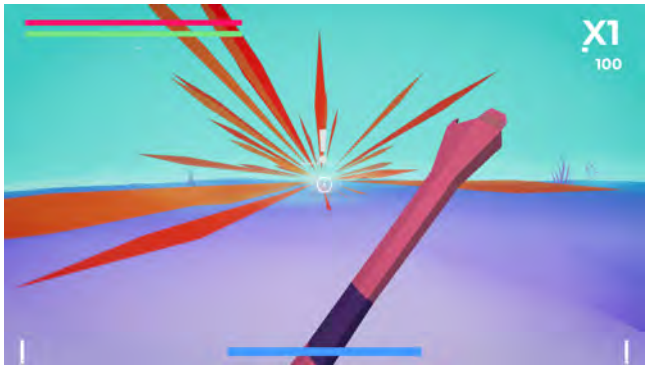

Figure 4.24: Displayed is the particle effect that accompanies an enemies death.

Figure 4.25: Displayed is the particle effect that is visible when the player dashes.

Enemy Death Effects. When an enemy dies in the base version the sprite fades out and then the soul crystals spawn. In the juicy version an additional explosion particle effect is added on the enemy's death (see Figure 4.24). Additionally when an enemy dies there is a small amount of screen shake added to the player's camera.

Dash Effect. In the base version of the game when the player dashes there is no visual effects present beyond the player carrying out the movement. In the juicy version of the game when the player dashes they leave behind a dust particle effect on the ground where they dashed, and while dashing there is a particle effect present on the screen to visualise the increased movement. In addition to the particle effect, the camera also has a secondary animation effect of tweening to the direction of the dash. See Figure 4.25 for an example.

Weapon Animation. The base version of the game has a animation that plays when the player attacks that swings the weapon. In the juicy version, this animation remains the same, but an additional trail effect is added to the weapon to signify

Figure 4.26: Visible is the trail effect that follows when the weapon is swung.

Figure 4.27: Visible are the speed lines that display when the player is falling.

its speed. Additionally, the camera has slight animation movements based on the direction of the swing. See Figure 4.26.

Landing Effect. During the transition phase between levels, the player's score and statistics such as enemies killed are displayed; in the juicy version, these statistics are animated into the screen rather than appearing stationary. While the player character is falling to the next level, the juicy version also has speed lines to emphasise the high velocity of movement, created through a particle effect (see figure 4.27). Additionally, when the player lands on the next level, there is a visual effect created where the player landed (See Figure 4.28).

Camera Animation. In the base version of the game, the camera remains fairly static. While it follows the players movement and moves around with the mouse to allow the player to aim, it does not convey the weight of any movement or action. In the juicy version the camera reacts to player input and actions with secondary

Figure 4.28: An example of the landing effect that is displayed when the player lands on a new level.

Figure 4.29: A screenshot of the added skull particles and fog in the level barrier in the juicy version.

movement, e.g. when the players lands from a jump, the camera pans down slightly to give the illusion of weight and bounce.

User Interface Effects. The base version of the game's user interface contains all the necessary information, but all of the elements like the health bar or the score indicator are static. In the juicy version all of the elements have had an animation effect added to them allowing them to react to the movement of the player whilst also showing slight ambient movement.

Environment Ambience. Several different VEs have been added to the environment in the juicy version. The first is that the barrier that prevents moving to the next level has floating skulls and a fog effect added (see Figure 4.29). Additionally the grass tufts present throughout have an animation effect added in the juicy version. Lastly floating dust particles have been added throughout all of the environment in the juicy version.

Implementation

Design Rationale *Dungeon Descent* was designed and implemented by me, and as such much of my previous experience as a games developer has impacted the implementation of the game. Unlike *Frogged Cubed*, this game was not a copy of an existing experience and instead a novel design, although it does leverage heavily from my experience. As a designer I have previously worked on a commercially released action game, and while *Dungeon Descent* is different in it's core experience many of the lessons learned from the development were carried forwards to help ensure the game was as positive an experience as possible. An example of how these lessons manifested in the design of *Dungeon Descent* is through the way that the game only contains three type of enemies, previously I had found that including more than a couple of enemies can overwhelm the player as they would be exposed to many new patterns one each play though and I wanted to create as consistent experience as possible for each player. My previous experience also informed the design of the juicy elements in the game for example, the way that the character rotates with the mouse was made juicy through having the characters equipped weapon rotate and slightly move in the direction of the rotation, creating a second order of motion for all movement that the player causes. I had used this technique previously and had positive feedback from players.

Technical *Dungeon Descent* was created in Unity3D 2018 [144]. All artwork, models, audio, and code were created by the author for this thesis. Models were created using Blender 2.7 [22]. Audio was created using Audacity 2.1.3 [5]. Textures and other miscellaneous art assets were made with Paint.Net 3.8 [35]

4.1.4 Validation of Juiciness Elements

After the research games were completed they were then validated, to ensure that the juicy versions, as were designed, were perceived as containing suitable juicy elements, and that the standard versions were perceived as not containing comparable juicy elements (but could still be considered finished and polished games). To this end, four

game designers were recruited who played through each version of *Frogged Cubed* and *Dungeon Descent* independently, and then applied the juicy framework, reporting on whether the game met each of the framework's questions. Designers played each version of the game for 30 minutes, at which point they went through each question in the framework answering "yes" or "no", providing a rationale for their answers when needed. Using the framework, all four designers confirmed that the juicy version comprised appropriate juicy features in line with the framework and other work in this field, that the standard version did not, and that the differences between both versions were clear when compared directly.

4.1.5 Study 1: Research Games

Presented in this section is a user study exploring the effects of VEs on players. First an overview of the research questions, hypotheses and measures is presented. Then, the findings from the first study with 40 participants exploring the effects of juiciness in research games are reported. Presented is a within-subjects study exploring the effects of juiciness on player experience, performance and overall player perspectives using *Frogged Cubed* and *Dungeon Descent*. These two research games were chosen for this first exploration as they allow for full control over the integration of juiciness.

Research Questions and Hypotheses

This study aims to address the following two main research questions (RQs) concerned with the relationship of players and juiciness:

RQ1: Does juiciness - implemented as VEs - improve player experience?

Literature suggests that juiciness leads to improvements in player experience, often on the basis of improved visual appeal [142, 77]. Therefore the following hypotheses were formulated.

H1a: VEs increase the aesthetic appeal of games.

H1b: VEs improve the overall player experience.

RQ2: Does juiciness have an impact on player performance?

Previous work suggests that juiciness contributes to player competence [31]. This question explores whether juiciness affects perceived competence or objective player performance; this led to the following hypotheses:

H2a: VEs improve perceived competence.

H2b: VEs improve objective player performance.

Measures

The study makes use of a number of different measures to address the research questions including standardised questionnaires, custom open ended questionnaires, and player metrics.

Questionnaires

The study made use of three questionnaires: Player Experience Inventory [149], Player Experience Needs Satisfaction [129] and, AtrrakDiff2 Questionnaire [59] these were used to explore the impact of juiciness on players, along with an open-ended exit questionnaire that collects overall feedback including qualitative statements.

Player Experience. To evaluate player experience, the Player Experience and Needs Satisfaction (PENS) questionnaire and the Player Experience Inventory (PXI) were used. The PENS is validated and a de-facto standard in games research (e.g., see [3], [62] and [16] for examples of its application in the games research community). It builds on SDT [126, 129] and includes sub-scales for Competence, Autonomy, Presence, Relatedness, and Intuitive Controls. Participants are asked to rate statements such as "I feel competent at the game" on a 7-point Likert scale. The PXI is a novel tool for the assessment of player experience that makes a distinction between psychological and tangible factors [149]. The PXI contains sub-scales for Mastery, Curiosity, Immersion, Autonomy, Meaning, Clarity of Rules and Goals, Appeal, Challenge,

Ease of Control and Progress Feedback. Participants are asked to rate statements such as "I appreciated the aesthetics of the game" on a 7-point Likert scale.

Aesthetic Appeal. To measure the aesthetic appeal in general and visual attractiveness of the games in particular, an adapted AttrakDiff2 questionnaire was used [59]. The AttrakDiff2 is a validated measure that is commonly applied in user experience research (e.g., [57]). Although it has not been used extensively in games. The questionnaire examines pragmatic and hedonistic qualities, the hedonistic qualities measure perceived novelty and stimulation while the pragmatic qualities measure revolve around successful use. Participants are given two verbal anchors such as "Cheap" and "Valuable" at each end of a 7-point Likert scale. In addition to the explicit hedonic and pragmatic dimensions, the AttrakDiff2 also has dimensions of beauty which explores the visual aesthetic appeal and goodness which covers the pleasure of use.

Direct Player Feedback. An exit questionnaire was used with questions that asked participants about differences between conditions, as well as ratings of subjective enjoyment on a 7-point Likert scale. Participants were also asked to provide open-ended comments on player preferences along with the idea of juiciness.

Game Metrics

Dungeon Descent and *Frogged Cubed* log a variety of game metrics in order to look at the effects of juicy design on performance and behaviour. *Dungeon Descent* records the score and combo multiplier, weapon accuracy and levels cleared as performance metrics. Additionally, for behavioural metrics, it records how many times the player performed actions such as jumping or attacking, and positional data to explore player behaviour. Performance metrics recorded for *Frogged Cubed* include the score, lives lost, time spent per level and levels cleared.

Participants and Procedure

40 participants were recruited (23 male, average age 26, SD=7.6) through word of mouth, mailing lists and, social media sites. When screening for visual impairments that might interfere with study participation, two participants reported colour vision deficiency, but later on indicated that they were able to discern juicy elements with no issues and were therefore retained in analysis. Of the participants, 28 were experienced players (more than 5 hours of regular gameplay per week); 6 were casual players (1-4 hours a week), and 6 were not actively playing games. The research protocol was approved by the ethics board at the University of Lincoln, UK.

At the start of the study, each participant was given information on the study, and asked to provide informed consent. The study was split into four sequences consisting of one of the conditions (*Standard, Juicy*) of *Frogged Cubed* and *Dungeon Descent*, counterbalanced using a Latin square to control for order effects). In each condition, participants were asked to play each of the game versions on PC for at least 5 minutes but were permitted to play up to 10. After each condition, participants were asked to fill out the questionnaires on player experience, and aesthetic appeal. At the end of the study, participants were asked to complete the exit questionnaire which involved rating the enjoyment of each of the games. Additionally, demographic information along with information on their gaming habits was recorded in this questionnaire. Finally, participants were given the opportunity to ask questions related to the study and research, and thanked for their participation. On average, sessions lasted about 75 minutes.

Data Analysis

Quantitative data were analyzed in SPSS 22. Applied was a two-way repeated measures ANOVA with Embellishment (*Standard*, *Juicy*) and Game (*Frogged Cubed*, *Dungeon Descent*) as within-subject factors for questionnaire data (PENS, PXI, and AttrakDiff2) and post-play enjoyment ratings. Pairwise comparisons were made with Bonferroni correction. Performance data were analyzed with paired-samples t-tests.

Results

The results section is organised according to this chapters research questions. Quantitative findings are supplemented with qualitative participant feedback.

RQ1: Does Juiciness Improve Player Experience? Juiciness does improve player experience in both research games in terms of visual appeal, and related constructs such as curiosity, immersion and meaning. However, it does not affect player experience in terms of needs satisfaction.

H1a: VEs increase the aesthetic appeal of games. The results support H1a, suggesting that juiciness increases the aesthetic and visual appeal of the two research games. Results for the AttrakDiff (see Table 4.2) reveal a significant main effect of embellishment on the dimensions of hedonic identification (HQI) and stimulation (HQS), but no interaction between game and embellishment, suggesting that juiciness increased hedonic quality across conditions (see Table 4.2. However, for the items of Beauty and Goodness, there was no significant difference, suggesting juiciness does not improve the perceived beauty or pleasure of the game. The PXI revealed a significant main effect of juiciness on the dimension of audiovisual appeal, but no interaction between game and embellishment, suggesting that the concept improved player perceptions across games. Qualitative participant responses support the notion of juiciness improving the aesthetic appeal of games, e.g., one participant noting that the games "*felt more immersive in the [juicy] version, and visually more appealing*" (P27).

H1b: VEs improve the overall player experience. The results partially support this hypothesis with respect to the two research games. There were no significant main effects of juiciness on any of the scales of the PENS, and no interaction effects (see Table 4.2), the PXI component of Autonomy also did not show a significant difference, suggesting that in this particular setting, juiciness does not contribute to the satisfaction of player needs as defined by SDT. However, the PXI revealed significant main effects of juiciness on the dimensions of Immersion, Meaning, Curiosity, and no interaction effects between game and VEs. The effect of Curiosity needs to be inter-

preted in the light of the interaction between game and embellishment, suggesting that the impact in *Frogged Cubed* was the driving element. These results support the hypothesis that juiciness does have an effect on some elements of player experience, particularly those directly relating to game visuals (e.g., immersion, or curiosity instilled by interesting visual effects). Qualitative participant responses also reflect differences in player experience, with participants expressing the juicy versions *"felt"* better, e.g., "*[...] the special effects on the enemies when they died and movement felt more real*" (P7). Participants also reflected on the changes to the experience juiciness provided "*I preferred the second version (Juicy Frogged Cubed) because it just felt more engaging and interactive when playing.*" (P3). However, these results do not seem to affect overall enjoyment of the conditions, which all achieved similar ratings ($M_{\text{Frogged Cubed Standard}} = 4.8, SD_{FroggedCubedStandard} = 1.771, M_{\text{Frogged Cubed Juicy}} = 4.9, SD_{FroggedCubedJuicy} = 1.958, M_{\text{Dungeon Standard}} = 4.95, SD_{DungeonStandard} = 1.518$, $M_{\text{Dungeon Juicy}} = 5.07, SD_{DungeonJuicy} = 1.384$). There was no significant main effect of game $F_{1,39} = .198$, $p = .659$, $\eta^2 = .005$, or embellishment $F_{1,39} = .552$, $p = .462$, $\eta^2 = .014$, and no interaction between Game and Embellishment $F_{1,39} = .003$, $p = .957$, $\eta^2 = .000$.

RQ2: Does Juiciness Have an Impact on Player Performance? The results do not support the idea that juiciness can be leveraged to improve player performance, or increase perceived competence in the two games.

H2a: Visual embellishments improve perceived competence. The results do not support H2a. To explore changes in perceived competence, the relevant PENS and PXI dimensions were analysed (see Table 4.2). For the Competence dimension of the PENS, there were no significant effects. For the PXI, the dimensions of Mastery and Challenge were analysed, with no significant effects found. Interestingly, participant responses were ambivalent regarding the effects of juiciness in terms of performance. For example, one participant expressed higher levels of competence in the standard version, "*the player controls were more to what I'm used to (not a lot of screen shake/head motion when attacking), which made it easier for me to control my character*" (P15), whereas another participant commented that "*Juicy Cuber was slightly more difficult as the animations meant slightly more to focus on*"

(P38), suggesting that the interpretation of the effects of elements of juicy design on perceived competence was highly individual. In this context, it is important to note that there were no significant differences in Ease of Use (PXI) or Intuitive Controls (PENS) between standard and embellished game versions, suggesting that the basic usability provided by both game versions was perceived as comparable (see Table 4.2).

H2b: Visual embellishments improve objective player performance. To measure whether the inclusion of visual juiciness had an effect on player performance in the two research games, several metrics between the standard and embellished version of each game were compared. For *Frogged Cubed*, the amount of levels cleared, amount of deaths, and score, were also compared finding no significant differences between any metrics (see Table 4.1). For *Dungeon Descent*, the amount of levels cleared, score, amount of deaths, kills, and accuracy were compared. No significant differences were found between any of these metrics either (see Table 4.1). Therefore, the data does not support H2b.

Summary of Findings

The results of this first study show that VEs have a direct impact on the perceived visual appeal of the two research games, but do not affect underlying elements of the player experience (e.g., perceived competence) and do not extend to objective measures of player performance. This is in line with previous findings [49, 78]; however, previous work and the first study in this chapter have relied on research games or ad-hoc setups for the study of juiciness. Therefore it would be insightful to learn more about the effects of VEs in commercially available games, which is also relevant given the large industry interest in the concept.

Table 4.1: Player performance metrics, mean values (SD).

	Metric	Base	Juicy	p
Frogged Cubed	**Levels Cleared**	4.5 (1.48)	4.45 (1.50)	$p = .772$
	Deaths	10.30 (6.41)	9.22 (5.64)	$p = .316$
	Score	3988.50 (1291.88)	3941.50 (1303.47)	$p = .781$
DungeonDescent	**Accuracy**	43.27% (0.13)	44.41% (0.19)	$p = .670$
	Kills	49.45 (29.29)	50.77 (26.42)	$p = .808$
	Levels	6.77 (3.33)	6.35 (2.42)	$p = .494$
	Deaths	1.27 (1.03)	1.22 (0.86)	$p = .785$
	Score	473,062 (621,307)	317,800 (371,073)	$p = .206$

Table 4.2: Means, Standard Deviation, Reliability, and Effects split by game and condition for each dimension. * represents significance

		Frogged Cubed				Dungeon Descent						
		Standard		Juicy		Standard		Juicy		F-scores of Game	F-scores of Embellishment	F-scores of Game x Embellishment
PENS	**Competence**	5.59(1.27)	α.865	5.57(1.3)	α.843	4.58(1.56)	α.899	4.55(1.46)	α.879	$F1,39 = 30.8$, $p = .000$, $\eta^2 = .441$*	$F1,39 = 0.38$, $p = 0.847$	$F1,39 = 0.013$, $p = 0.971$
	Autonomy	3.55(1.03)	α.589	3.81(1.25)	α.725	4.82(1.27)	α.844	4.69(1.47)	α.869	$F1,39 = 22.853$,$p = .000$, η^2.369*	$F1,39 = .295$,$p = .590$*	$F1,39 = 2.334$,$p = .135$
	Presence	2.82(1.08)	α.808	3.06(1.17)	α.820	3.33(1.21)	α.841	3.53(1.35)	α.893	$F1,39 = 7.216$,$p = .011$, η^2.156*	$F1,39 = 3.125$,$p = .085$	$F1,39 = 0.76$,$p = .784$
	Int. Controls	6.14(1.22)	α.816	6.28(1.08)	α.882	5.17(1.74)	α.901	5.31(1.64)	α.902	$F1,39 = 33.503$,$p = .000$, η^2.462*	$F1,39 = 2.138$,$p = .152$	$F1,39 = .000$,$p = 1.000$
PXI	**Mastery**	5.09(1.32)	α.885	5.48(1.38)	α.924	4.52(1.60)	α.919	4.48(1.54)	α.906	$F1,39 = 17.352$,$p = .000$, $\eta^2 = .308$*	$F1,39 = 1.324$,$p = .257$	$F1,39 = 3.242$,$p = .080$
	Curiosity	3.75(1.85)	α.957	4.62(1.64)	α.919	4.84(1.68)	α.964	4.88(1.51)	α.944	$F1,39 = 7.179$,$p = .011$, $\eta^2 = .155$*	$F1,39 = 9.289$,$p = .004$, $\eta^2 = .192$*	$F1,39 = 7.196$,$p = .011$, $\eta^2 = .156$*
	Immersion	4.64(1.39)	α.855	5.25(1.21)	α.870	4.86(1.35)	α.861	5.03(1.42)	α.918	$F1,39 = .000$,$p = .982$	$F1,39 = 8.165$,$p = .007$, $\eta^2 = .173$*	$F1,39 = 2.372$,$p = .132$
	Autonomy	3.77(1.35)	α.807	4.12(1.26)	α.768	4.77(1.27)	α.806	4.71(1.55)	α.932	$F1,39 = 10.622$,$p = .002$, $\eta^2 = .214$*	$F1,39 = 1.017$,$p = .320$	$F1,39 = 4.400$,$p = .042$, $\eta^2 = .101$*
	Meaning	3.30(1.39)	α.865	3.98(144)	α.821	3.57(1.47)	α.814	3.80(1.64)	α.901	$F1,39 = 0.59$,$p = .809$	$F1,39 = 18.277$,$p = .000$, $\eta^2 = .319$*	$F1,39 = 2.403$,$p = .129$
	Clarity	6.28(.89)	α.914	6.33(1.01)	α.892	5.90(.98)	α.824	5.90(1.13)	α.948	$F1,39 = 14.385$,$p = .001$, $\eta^2 = .269$*	$F1,39 = 0.69$,$p = .794$	$F1,39 = 0.66$,$p = .799$
	Appeal	4.68(1.41)	α.907	5.22(1.27)	α.844	5.09(1.35)	α.898	5.32(1.53)	α.966	$F1,39 = 2.266$,$p = .140$	$F1,39 = 8.028$,$p = .007$, $\eta^2 = .171$*	$F1,39 = 1.668$,$p = .204$
	Challenge	5.15(1.38)	α.838	5.40(1.37)	α.923	4.50(1.43)	α.894	4.63(1.35)	α.893	$F1,39 = 10.004$,$p = .003$, $\eta^2 = .204$*	$F1,39 = 3.235$,$p = .080$	$F1,39 = .201$,$p = .657$
	Ease	6.25(.97)	α.921	6.31(1.15)	α.949	5.43(1.64)	α.949	5.35(1.55)	α.950	$F1,39 = 28.963$,$p = .000$, $\eta^2 = .426$*	$F1,39 = .014$,$p = .907$	$F1,39 = .806$,$p = .375$
	Progress	5.19(1.19)	α.800	5.45(1.34)	α.824	5.04(1.39)	α.836	5.11(1.43)	α.888	$F1,39 = 2.040$,$p = .1614$	$F1,39 = 2.098$,$p = .155$	$F1,39 = .884$,$p = .353$
PANAS	**Positive Affect**	26.32(9.73)	α.919	27.55(9.74)	α.885	28.67(8.48)	α.913	28.27(8.71)	α.927	$F1,39 = 1.590$,$p = .215$	$F1,39 = .295$,$p = .590$	$F1,39 = 1.396$,$p = .245$
	Negative Affect	13.15(4.75)	α.657	12.40(4.59)	α.880	19.10(19.26)	α.771	14.87(6.66)	α.771	$F1,39 = 6.264$,$p = .017$, $\eta^2 = .138$*	$F1,39 = 2.692$,$p = .075$	$F1,39 = 3.342$,$p = .079$
AtrakDiff2	**Hedonic Identification**	3.71(.830)	α.713	4.03(.977)	α.789	4.00(.855)	α.763	4.18(1.11)	α.895	$F1,39 = 3.141$,$p = .084$	$F1,39 = 6.917$,$p = .012$, $\eta^2 = .151$*	$F1,39 = .854$,$p = .361$
	Hedonic Stimulation	3.31(1.06)	α.782	3.87(1.14)	α.782	4.28(1.11)	α.844	4.60(1.00)	α.908	$F1,39 = 20.201$,$p = .000$, $\eta^2 = .341$*	$F1,39 = 16.130$,$p = .000$, $\eta^2 = .293$*	$F1,39 = 1.499$,$p = .228$
	Pragmatic Quality	5.41(.803)	α.733	5.32(.835)	α.764	4.51(1.04)	α.798	4.49(1.05)	α.878	$F1,39 = 44.932$,$p = .000$, $\eta^2 = .535$*	$F1,39 = .507$,$p = .481$	$F1,39 = .225$,$p = .638$
	Beauty	4.17(1.25)	N/A	4.75(1.31)	N/A	4.87(1.26)	N/A	4.87(1.62)	N/A	$F1,39 = 5.160$,$p = .029$, $\eta^2 = .117$*	$F1,39 = 3.914$,$p = .055$	$F1,39 = 4.03$,$p = .051$
	Goodness	5.32(1.16)	N/A	5.77(1.02)	N/A	5.27(1.39)	N/A	5.22(1.42)	N/A	$F1,39 = 2.068$,$p = .158$	$F1,39 = 2.986$,$p = .092$	$F1,39 = 2.438$,$p = .127$

4.1.6 Study 2: Commercial Game - Quake III Arena

Quake 3 was selected as research tool because the game strongly emphasises competition and performance through elements of juicy design (see below), while offering straightforward gameplay suited to single-session lab studies. Furthermore, these off-the-shelf customisation options can easily be toggled, making it a suitable candidate for this research. The game has previously been leveraged as research tool [6] and largely falls in line with recommendations for selection of games for research studies [145].

Game Description

Quake 3 Arena is a first-person shooter first released in 1999 [139], and re-released in 2010 as online version under the name *Quake Live* [167]. Today, the game is available via Steam and is still actively played across the world [118]. The game is geared toward competition and does not feature extensive narrative elements. The goal of the game simply is to try and defeat - or *frag* - as many opponents as possible. To this end, the player controls an avatar in an arena, and must move around to collect weapons and power-ups while attempting to kill opposing players (AI-controlled in single player mode, or human competitors). If the player is killed before the end of the level, they respawn at one of several predefined points in the level, but lose all weapons and power-ups. At the end of each level (determined either through frag or time limit), an overview of scores is presented to players. The game features a range of competition modes (e.g., duel, free for all, team deathmatch). In this study, a single player competition against several AI-controlled opponents at medium difficulty, to provide a comparable experience to all participants.

Juicy Elements

The juicy elements for this study were constructed in a similar manner to the previous approach; the configuration of visual embellishments for the juicy version of the game was done following guidelines laid out by [31, 78].

Figure 4.30: A screenshot of an enemy player exploding into gore and gibs.

Blood Effects.In the juicy version, enemies emit an additional particle effect resembling blood when hit by the player; when killed they explode into a fountain of blood and gore (Figure 4.30). These elements are in line with those implemented in *Dungeon Descent*.

Weapon trail effect. In the juicy version certain weapons have additional trailing particles effects for the projectiles fired such as the rocket launcher and plasma gun. See Figure 4.31.

3D Items. In the juicy version all collectable items (e.g., power-ups, weapons) are integrated into the environment as 3D objects with bounce and spin animations rather than simple 2D icons. See Figure 4.32 for a comparison of the items.

Participants and Procedure

32 participants were recruited (21 male, average age 23, SD=3.58) through word of mouth, mailing lists and social media sites; this participant sample for this study was separate to the previous study. When screening for visual impairments that might interfere with study participation, two participants reported colour vision deficiency, but later on indicated that they were able to discern juicy elements without issues

Figure 4.31: Visible is one of the extra particle effects added to the plasma gun in the juicy version.

Figure 4.32: This figure shows on the the simple item (left) and the juicy item (right).

and were therefore retained in analysis. Of the participants, 26 were experienced players (more than 5 hours of regular gameplay per week), 4 were casual players (1-4 hours a week), and 2 were not actively playing games. Participants were generally familiar with first-person shooters including the Quake family. The research protocol was approved by the ethics board at the University of Lincoln, UK.

At the start of the study, each participant was given information on the study, and asked to provide informed consent. The study was split into two sequences consisting of one of the conditions (*Standard, Juicy*) of the PC version of *Quake 3*, counterbalanced to control for order effects). Participants were asked to play each

of the game versions for nine minutes broken into three rounds of three minutes. This amount of time was chosen to create a somewhat realistic and complete experience where participants were subject to the whole gameplay loop. After each condition, participants were asked to fill out the questionnaires on player experience, and aesthetic appeal. At the end of the study, participants were asked to complete the exit questionnaire which involved rating the enjoyment of each of the game versions and ranking them for preference. Additionally demographic information along with information on their gaming habits was recorded in this questionnaire. Finally, participants were given the opportunity to ask questions related to the study and research, and thanked for their participation. On average, sessions lasted about 45 minutes.

Data Analysis

Quantitative data were analyzed in SPSS 22. Data were run through paired-samples t-tests with Embellishment (*Standard*, *Juicy*) as within-subject factors for questionnaire data (PENS, PXI, and AttrakDiff2), post-play enjoyment ratings, and performance data. Cohen's d was calculated as a measure of effect size.

Results

Similar to the first study presented, results are organised by research questions, and quantitative findings are supplemented with qualitative participant feedback.

RQ1: Does Juiciness improve player experience? Juiciness improves player experience in *Quake 3*, with the juicy version of the game receiving significantly higher ratings for visual appeal, curiosity, and immersion (see Table 4.3; mirroring findings of the first study). However, the results further suggest that juiciness also positively influences player experience with respect to need satisfaction, suggesting that juicy elements included in *Quake 3* had different effects than those employed in the first study.

H1a: VEs increase the aesthetic appeal of games. The results extensively support

H1a, suggesting that juiciness conceptualised through VEs have a positive impact on the aesthetic and visual appeal of the game. Results from the AttrakDiff2 reveal a significant effect of embellishment on HQI and HQS, suggesting that juiciness increased hedonic quality, as well a significant effects on the dimensions of Beauty and Goodness. The PXI revealed a significant effect of juiciness on the dimension of audiovisual appeal, re-emphasising that juiciness enhanced the perceived visual appeal of the game. Qualitative results also back these results, with participants expressing the juicy elements made the game more appealing e.g., "*I found the version with the 3D pickups (juicy version) more visually appealing due to the more satisfying particle effects and the clearer pickups*" (P19), and that they appreciated the realism of the effects, e.g., *"[there was] better blood splattering, so better visuals"* (P16) or *"the [juicy] version was more visually appealing because of the particle effects and stuff. And that death thing with the limbs is just amazing!"* (P29).

H1b: VEs improve the overall player experience. The results generally support this hypothesis. Considering the overview of implications of VEs for player experience (see Table 4.3), it can be concluded that overall player experience in *Quake 3* is better in the juicy condition: this version of the game scores better in terms of visual appeal, but also regarding perceived competence, presence (PENS), immersion (PXI) and curiosity (PXI). However, it is also important to note that a range of elements that constitute the player experience were not significantly affected by juiciness, most importantly, relatedness (PENS) and dimensions related to usability (PENS: Intuitive Controls, PXI: Ease of Use, Clarity). Qualitative participant responses also fall in line with these results, with participants considering the juicy version more desirable and rounded, e.g., *"the [juicy] version felt like a well welded game in all its glory. Whereas [the base version] felt as if something has either missing, or incomplete"* (P32). This is also reflected in the effect of Juiciness on the overall enjoyment of the game with the juicy version ($M = 6.34, SD = 1.20$) rated significantly ($p <= .001$) higher than the base version ($M = 5.03, SD.70$).

RQ2: Does Juiciness have an impact on player performance? The results show that juiciness positively influenced perceived competence, but that objective player performance remained unchanged.

H2a: VEs improve perceived competence. The results suggest that the juicy version of *Quake 3* significantly increased perceived competence. For the PENS, the dimension Competence was analysed; the result was also reflected in the associated PXI dimension of Mastery (see Table 4.3). Similar to the previous study, qualitative player feedback revealed more nuanced perspectives. For example, one participant pointed out that juicy elements affected their own perception of in-game actions, e.g., *"[...] hits on the player felt more satisfying [...]"* (P3). It is important to remember here that the results do not find significant differences in usability (PENS: Intuitive Controls, PXI: Ease of Use), and that there was no significant difference in perceived challenge (see Table 4.3). Likewise, there was no significant difference in the PXI dimensions of Progress Feedback and Clarity of Goals and Rules, suggesting that standard and juicy versions of the game were comparable in terms of the basic information that they provide to players (see Table 4.3).

H2b: VEs improve objective player performance. The results do not support this hypothesis. On examination of player performance indicators for *Quake 3*, there was no significant difference ($p = .606$) between the number of kills participants made in either the base ($M = 50.65, SD = 17.81$) or juicy version ($M = 52.06, SD = 19.47$). Furthermore, there was not a significant ($p = .061$) difference in the amount of player deaths between the base ($M = 11.28, SD = 3.22$) or juicy version ($M = 12.65, SD = 3.41$). Therefore, it can be concluded that juiciness does not improve objective performance in the game.

4.1.7 Summary of Quake 3 Arena Findings

The results of this second study show that VEs have a direct impact on the perceived visual appeal of *Quake 3 Arena*. The results show that juiciness in a commercial game has many of the same effects as found in the research game such as increased immersion. However, the results also reveal that in *Quake 3 Arena*, juiciness also has an effect on player perceived competence. The results found no difference in the performance of participants between conditions thus, juiciness in *Quake 3 Arena* does not contribute to player performance.

4.1.8 Overall Summary of Findings

The results show that VEs improve player experience (**RQ1**) across games, contributing to the perceived visual appeal of *Frogged Cubed*, *Dungeon Descent* and *Quake 3 Arena* alike (*H1a*). However, the effects of juiciness on other elements that contribute to overall player experience (*H1b*) needs to viewed in a more nuanced light: while the design strategy improved player immersion in both research games and the commercially available product, perceived player competence was only improved through the juicy elements integrated in *Quake 3*, while the dimension of meaning was only impacted in the research games. Considering player performance, Juiciness did not improve objective indicators of success in any game; because perceived player performance (*H2a*) was only affected in the commercial setting, juiciness does contribute to player performance but only in some circumstances (**RQ2**), and that its integration requires further reflection if the intention is to improve satisfaction of psychological player needs.

4.2 Discussion

This chapter has explored juiciness through the integration of VEs in two studies, first examining the first-person shooter *Dungeon Descent* and the casual game *Frogged Cubed*, and then focusing on the commercially available first-person shooter *Quake 3 Arena*. Findings show that juicy elements such as particle effects or animations have an impact on the aesthetic appeal of games, extending to curiosity and immersion experienced by players. However, the findings suggest that VEs only affect the satisfaction of basic psychological needs (e.g., competence and autonomy) under certain circumstances, and have no implications for player performance. Here, in this section the implications of the findings with focus on the impact of juiciness on players are discussed; in particular,4 updated considerations for visual aspects of juicy design, and reflect on the implications the results for the role of players as individuals with psychological needs and consumers of games.

4.2.1 The Impact of VEs on Players

Here, the results are discussed in the context of PX, and implications for design are presented that stem from this work.

Effects of VEs on Player Experience and Performance

The results show that juicy design elements improve the visual appeal of a game, and contribute to curiosity experienced by players (e.g., contributing to the player's desire to explore a virtual world) by adding visual interest, suggesting that the design strategy has tangible benefits for players. The findings from these studies further suggest that 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.

However, these results demonstrate that juiciness only had effects on some dimensions of the player experience that are linked with the satisfaction of psychological

Table 4.3: Means, Standard Deviation, Reliability, F-scores, and Cohen's d for each dimension of PENS, PXI and AttrakDiff2. * of Significance

		Standard		Juicy		Significance
PENS	**Competence**	5.22(.78)	α.219	5.57(.82)	α.505	$F1, 31 = 5.83$, $p = .022$, $d = .438$*
	Autonomy	4.67(1.05)	α.798	4.94(1.12)	α.696	$F1, 31 = 2.96$, $p = .095$, $d = .248$
	Relatedness	2.41(1.35)	α.788	2.21(1.08)	α.567	$F1, 31 = 1.36$, $p = .251$, $d = .161$
	Presence	3.16(1.26)	α.889	3.43(1.26)	α.85	$F1, 31 = 4.94$, $p = .034$, $d = .214$*
	Int. Controls	6.31(.68)	α.641	6.43(.74)	α.825	$F1, 31 = .94$, $p = .338$, $d = .174$
PXI	**Mastery**	5.43(.98)	α.685	5.78(.91)	α.817	$F1, 31 = 6.26$, $p = .018$, $d = .362$*
	Curiosity	3.74(1.50)	α.883	4.08(1.49)	α.81	$F1, 31 = 4.89$, $p = .035$, $d = .228$*
	Immersion	5.39(1.33)	α.902	5.86(1.06)	α.843	$F1, 31 = 7.59$, $p = .010$, $d = .393$*
	Autonomy	4.98(1.59)	α.947	5.43(1.16)	α.857	$F1, 31 = 4.17$, $p = .050$, $d = .321$*
	Meaning	4.13(1.30)	α.844	4.42(1.20)	α.809	$F1, 31 = 2.33$, $p = .137$, $d = .232$*
	Clarity	6.68(.44)	α.671	6.76(.44)	α.845	$F1, 31 = 1.44$, $p = .238$, $d = .175$
	Appeal	4.41(1.59)	α.911	5.04(1.49)	α.917	$F1, 31 = 9.59$, $p = .004$, $d = .403$*
	Challenge	4.41(1.81)	α.928	4.66(1.66)	α.878	$F1, 31 = .626$, $p = .435$, $d = .143$
	Ease	6.38(.58)	α.683	6.39(.67)	α.576	$F1, 31 = .006$, $p = .940$, $d = .012$
	Progress	6.11(1.00)	α.831	6.27(.97)	α.761	$F1, 31 = 2.05$, $p = .162$,, $d = .158$
AtrakDiff2	**HQI**	4.09(.83)	α.742	4.53(.72)	α.586	$F1, 31 = 12.81$, $p = .001$, $d = .563$*
	HQS	3.91(.81)	α.714	4.25(.94)	α.746	$F1, 31 = 7.33$, $p = .011$, $d = .380$*
	PQ	4.92(1.06)	α.838	5.16(.75)	α.642	$F1, 31 = 2.47$, $p = .126$, $d = .261$
	Beauty	3.56(1.24)	N/A	4.34(1.53)	N/A	$F1, 31 = 13.92$, $p = .001$, $d = .559$*
	Goodness	5.18(1.42)	N/A	6.03(.86)	N/A	$F1, 31 = 10.35$, $p = .003$, $d = .717$*

needs formulated within SDT (here: PENS competence and PXI mastery) in the commercially available game *Quake 3 Arena*. This effect could be a result of careful selection of juicy elements that have implications for player competence and trigger a visceral reaction: the realistic display of blood on injury, and exaggerated amount of blood and gore on death of an opponent (also see Figure 4.30) leveraged in the game effectively reinforced the notion of success, while similar but more simplistic features in *Dungeon Descent* (flashing enemies on injury, stylised explosion on death) did not achieve the same outcome. Additionally, the increased effect found in *Quake 3 Arena* lies in the visceral nature of the effects present (exaggerated gore), these effects help to create that visceral feeling that is attributed to juiciness. This would imply that juiciness needs to be designed with great care if the goal is to increase satisfaction of psychological needs through play: rather than introducing a wide range of general or abstract embellishments, the targeted use of realistic and contextually relevant VEs directly associated with player performance could offer tangible benefits for player experience. This suggests that juiciness needs to be framed more narrowly than suggested by initial definitions [77].

Effects of Individual Elements and the Perceived Whole

While the overall picture of the effects of Juiciness was clear, qualitative feedback suggested individual instances of players who only appreciated certain aspects of Juiciness, but not others (e.g., screen shake in *Dungeon Descent*, item representation in *Quake 3 Arena*), suggesting that juicy elements either need to be assessed individually to ensure they contribute to player experience, or should be implemented in a way that allows players to toggle undesired effects. At the same time, feedback also shows many instances where a positive experience on the basis of Juiciness emerged from the overall impression of the game (with players being unable to point out specific elements of juicy design). This supports the intangible nature of the phenomenon previously discussed in Chapter 3, suggesting that positive effects stem from the combination of multiple elements that contribute to a more positive play experience.

4.2.2 Understanding Players as Individuals With Various Needs

Recent efforts in games research overwhelmingly focus on players as individuals with psychological needs through the lens of SDT (e.g., [74, 151]). These results suggest that a broader perspective is required to explain the high-level effects of Juiciness. Here, approaches such as Uses and Gratifications theory could offer further insights: The theory assumes that individuals consume media with the goal of gratifying certain needs [88, 125]. Six gratifications have been associated with play: competition, challenge, social interaction, diversion, fantasy, and arousal [137]. The dimension of fantasy in particular - getting deeply involved in a virtual environment - relates to some of the findings, where VEs contributed to players' desire to explore the games (curiosity), and helped them have more engaging experiences (immersion). This suggests that Juiciness can help satisfy player needs related to media consumption, extending beyond the basic psychological needs as stipulated by SDT [116].

4.2.3 Relevance of Findings for Game Development

The effects of Juiciness have implications for both commercial game development, and the creation of games as research tools. From a commercial perspective, findings suggest that visual elements of juicy design are important contributors to the overall aesthetic perception of a game, serving as an indicator of quality and polish that players leverage to assess the quality of a game. This ties back to the role of players as consumers: if they are given a choice between different products, market research suggests that graphical quality plays an important role [147]; likewise, the findings highlight that players felt the juicy versions provided a more polished experience, or, as one participant put it, *"I think the extra feedback given just made the game look nicer and more professional."*. The importance of visual appeal and first impressions is also backed by research in other fields, e.g., readers judging books by their covers [156], or visitors forming an opinion of the visual appeal of websites within the blink of an eye [89]. At the same time, the absence of significant effects of juiciness on main

elements of player experience in research games (most importantly, autonomy along with competence) but presence in the commercially available product (increased perceived competence and mastery) has implications for the development of games as research tools: many implementations are visually simplistic (e.g., see [17, 86, 110]). This suggest that this strategy needs to be applied with care depending on the experience the research tool is intended to invoke.

4.3 Limitations

There are limitations to the work presented in this chapter that need to be considered when interpreting the findings of the two studies presented. Most importantly, the studies presented only explored effects of visual aspects of juiciness. Additionally the games explored cover only a small amount of genres. In terms of sampling, participants in this study particularly in the experienced gamer bracket were predominantly male. While this to some extent still is a reflection of the gamer population, the role of gender was not sufficiently explored in the context of the studies. This chapter only presents studies conducted in a pristine lab based environment, how do these results hold up when deployed as game in-the-wild? Finally, it would be interesting to compare the effects of VEs to other design strategies to increase the appeal of interactive applications, e.g., contrasting it with Gamification [33] approaches that focus on badges, levels, and leaderboards.

4.4 Conclusion

Game researchers and designers have hypothesised that juiciness can be leveraged as a means of comprehensively improving player experience. This chapter has shown that the design strategy needs to be applied and interpreted with care when focusing on VEs only: while the visual aspects of juiciness which were investigated contribute to the aesthetic appeal, perceived visual polish, and immersion of games, they only extend to more complex aspects (i.e., perceived competence) in the arguably more

carefully and comprehensively designed commercial game (but still do not have an impact on objective player performance). In this context, the work in this chapter contributes to the growing body of research exploring the impact of visuals of games on players, and provides a detailed study of factors that contribute to player experience, which is particularly relevant given the increasing application of games and game elements in settings that extend beyond entertainment.

Chapter 5

Juiciness In-The-Wild

The findings in the previous chapter explored the effects of juiciness on the players through a series of lab based studies, finding that juiciness in the form of VEs can have a significant effect on aspects of the player experience. This chapter builds on this work through presenting an exploration of the effect of juicy design on the first-time user experience (FTU) and player performance through an in-the-wild study of the game *Frogged Cubed*. In-the-wild refers to the methodology of deploying a software artefact in the real world outside of a laboratory setting. The findings presented reveal that the increased experience that juicy design provides does not translate to an increased amount of engagement in first time play sessions or measured player performance.

This chapter explores the potential of improving the first-time player experience through the addition of juicy VEs. It provide a novel contribution through exploring the interactions of juiciness and FTU using an in-the-wild approach, a second but important contribution from this study is the insights and lessons learned from running a in-the-wild user study. It presents reflections upon juiciness in the context of the FTU and engagement, and in wider issues facing games researchers regarding deploying and promoting research games. Lastly, plans for further study of juiciness, in the context of first-time engagement are discussed.

The work presented in this chapter makes the following three main contributions: (1) provides the first structured study of VEs in a deployed game setting and what effects this has on the FTU, (2) provides evidence that VEs have no measured effect on the length of initial play sessions or player performance, suggesting that the

increased player experience from juiciness does not translate into increased initial play time and (3) Provides discussions around the deployment of research games and the implications for future researchers.

5.1 Related Work

This section covers literature and previous work surrounding juiciness, FTU and in-the-wild approaches to games research.

5.1.1 First Time User Experience

The FTU of a game is a key moment for the player, where they initially encounter and learn the game's rules, mechanics and gameplay. Researchers have explored different aspects of this FTU, such as the first hour of play and its impact on whether a player continues engaging with a given game [23]. Likewise, Cheung et al. [21] focus on the first hour of play, finding that the inclusion of intriguing elements can predict engagement: if the player liked the feeling of a mechanic or game element, it is linked to an increased desire to play. The Game Approachability Principles are a series of heuristics designed to analyse the different elements that contribute towards the first-time player experience, such as clarity of the presentation of information and the feeling of control while playing [29, 30]. The initial exposure to a game through reviews has been explored by Livingston et al. [90], who found that players perceive the game differently depending on review content. In broader HCI literature, Karapanos et al. broke down the user experience over time into three phases; orientation, incorporation, and identification [80]. While all three of these phases are crucial to long term use in the context of FTU, the orientation phase is of interest: a positive orientation experience consists of high learnability and stimulation of the senses [80]. It is clear from this existing work present how important the FTU is but also the elements that contribute to creating a positive one. The findings presented in the previous chapter reveal that juiciness lines up with many of these elements in creating a positive FTU, which is what is further explored in this

chapter. While the FTU has been well researched, no work has currently explored what effect of juiciness has on this experience. Many of the aspects of *juicy design*, such as the increased information clarity and highlighting of important events falls in line with previous research on creating a positive FTU.

5.1.2 Lab vs In-The-Wild Game User Research

Playing games is typically an intrinsically motivating activity. Players voluntarily subject themselve to play [116], not because they are being rewarded, nor because they have been told to play in a lab setting. This creates a dilemma when investigating whether a design element increases motivation to play. Lab studies are the typical means of measuring this, but simply telling someone to "play as if you were at home" does not recreate the setting they may typically play games in [36]. A potential solution to this issue is to deploy the research game *in-the-wild*, to allow people to find and play of the own volition, creating as true as an experience as possible [19].

5.1.3 Deploying Research Games

In-the-wild deployments have been well studied within the HCI community, with research exploring their effect at civic engagement [134]. Gordon and Baldwin deployed an online civic learning game in-the-wild as a way of increasing the quality and confidence of the engagement [52]. Academics have also collaborated with industry to explore aspects of the PX in a deployed game setting [45, 44]. While work exists that explores existing commercial games, or deploying and recruiting people to play, relatively little work looks at games created by researchers to be played voluntarily and the associated challenges.

5.2 Case Study: Frogged Cubed

This section examines the effect of juiciness on player FTU through an in-the-wild approach using the research game *Frogged Cubed*, that was used as a game to evaluate the effect of juiciness on player experience in the previous chapter. The version of the game that was used for this study can be played at www.playfroggedcubed.com.

5.2.1 Game Description

As previously described *Frogged Cubed* is a research game based on the classic arcade game *Frogger* that was designed to evaluate the differences that visual juicy elements have on player experience; this particular game has previously been used in games research [49] and there is a long-standing history of games research drawing from implementations of old arcade classics (e.g., [3]). To this end the game is designed with two versions. The first is the *Base* version, which contains the standard feedback elements such as audio and visual feedback. The juicy version contains additional visual feedback. The game play consist of moving a purple cube across an isometric environment that is filled with moving hazards to reach one of the five goal points. Each level is completed when five purple cubes have successfully been navigated to five different goal positions, meaning the player has to find five different paths through the level to successfully complete it. The game also has a limited amount of time for the level to be completed, which encourages risky strategies to be taken in order to complete the level in time. See section 4.1 for a full description.

5.2.2 Juicy Elements

The juicy elements that are present in the WebGL version of the game are identical to the version of *Frogged Cubed* detailed in the previous chapter. However, some of the juicy elements needed to be reworked to function in a WebGL environment. The first was the animation effect added to all the objects that made them bounce along with the rhythm of the background music. The unity web-player with WebGL

does not allow for multi-threading in the same manner as the original version so a new solution was created that samples the music and then uses that sample to guide the frequency and scale of the pulse. Visually this effect is identical in both versions. Secondly the particle effect that is created when the player moves used a several HLSL shader features that are not available in the Unity web-player, to get around this the effects were recreated using the standard Unity3D particle system. The result is a similar visual effect. The other juicy elements remained functionally and visually the same.

5.3 Study: Effects of Juiciness on Engagement

This section presents an in-the-wild deployment study that uses the game *Frogged Cubed* as a case study game to explore effects on juiciness, voluntary initial engagement, and repeat engagement. findings are reported from an in-the-wild deployment with 35 participants. Two research questions are addressed surrounding the effect that juiciness has on the initial player engagement.

5.3.1 Research Questions and Hypotheses

This study aims to address the following two main research questions (RQs) concerned with first-time user experience and return engagement:

RQ1: Does juiciness - implemented as VEs - have an effect does on initial engagement?

The previous chapter and literature [31, 142, 133] suggest that juiciness improves the player experience including dimensions of SDT. Therefore the following hypothesis was formulated.

H1: VEs will increase the length of the initial play session.

RQ2: Does juiciness - implemented as VEs - have an effect on return engagement?

The previous chapter and literature suggest that juiciness facilitates a higher visual

appeal and increases aspects of SDT that lead to high quality intrinsic motivation. Therefore the following hypothesis was formulated.

H2: VEs will increase the frequency that players return for separate play sessions.

5.3.2 Measures

For this study it was opted to not make use of measures such as questionnaires or interviews, as this would interfere with the true to life play experience that was trying to be achieved. Instead, use of game metrics as the main measure of evaluation, that related to player performance and behaviour. These metrics included the duration of play in the first session, duration of play of each level, total duration of play across all sessions, what score the player achieved on each level, the max level completed, how many deaths the player had on each level and overall deaths. Additionally to see if players returned, timestamps were recorded of play sessions tied to an anonymous identification number. A play session would be marked as separate if a participant left the website and then came back to play the game at a later time.

5.3.3 Participants and Procedure

The game *Frogged Cubed* was deployed onto the website: *www.playfroggedcubed.com*, where the full game was playable in a browser. The game was promoted through social media such as Twitter and Reddit. The contents of all promotion material surrounding the nature of the game and that it was free to play with study aspects being omitted at the promotional level e.g. "*Go play my Frogger inspired game it's free. http://playfroggedcubed.com #madewithunity #gamedev #free*". The game was available to play for two months, in this time there were 35 unique participants who played the game and completed at least one level. 18 participants played the base version and 17 participants played the juicy version. No demographic data was recorded to preserve the natural game setting. When initially playing the game participants were briefed that metrics were being recorded and would be used for academic purposes, and were asked to provide consent. Additionally, upon first

loading the game, participants would be assigned either the base or juicy version that would persist between play sessions, so each participant was only ever exposed to one version. The research protocol was approved by the ethics board at the University of Lincoln, UK.

5.3.4 Results

The results section is organised by the two research questions; data were analysed in SPSS V22 using paired sample t-tests.

RQ1: Does juiciness have an effect on initial engagement? The results do not support that juiciness has an effect on the initial measurements of engagement (see Table 5.1).

H1: VEs will increase the length of the initial play session. Participant play time was not significantly different between conditions ($M_{\text{Base}} = 234$, $SD_{Base} = 216$,$M_{\text{Juicy}} = 217$, $SD_{Juicy} = 208$, $t(16) = .205, p = .840$), participants played the base version for just over three minutes of gameplay (3 minutes and 53 seconds), and the juicy version for a similar amount (3 minutes and 37 seconds). For the metric of levels cleared there was no significant difference ($M_{\text{Base}} = 3.05$, $SD_{Base} = 1.98$,$M_{\text{Juicy}} = 2.76$, $SD_{Juicy} = 2.30$, $t(16) = .375, p = .713$) between conditions. The results do not support this hypothesis.

RQ2: Does juiciness have an effect on return engagement? The results do not support that juiciness has an effect on the frequency or duration a player returns to play the game.

H2: VEs will increase the frequency that players return for separate play sessions. From the 35 participants, only one participated in multiple play sessions, this individual was exposed to the Base version. The results do not support this hypothesis.

Metric	Base	Juicy	P-value
Time Played (Seconds)	234(216)	217(208)	$p = .840$
Levels Cleared	3.05(1.98)	2.76(2.30)	$p = .713$
Deaths	7.76(9.80)	7.35(8.81)	$p = .894$
Score	3652.35 (2537.17)	3327.64 (3208.03)	$p = .769$

Table 5.1: Means, Standard deviations and p-values of the player metrics that were stored

5.4 Summary of Findings

The results show that juiciness has no effect on engaging players in a wild setting, with participants who played the juicy version not having significantly longer or more frequent play sessions. The addition of these visual elements had no effect on any measured metric that was collected in this setting. Participants performed equally well across both conditions, which falls in line with the findings in the previous chapter. However, the differences in player experience found in the previous chapter in the context of a lab study did not translate to a difference in voluntary engagement in an in-the-wild setting.

5.5 Discussion

The work presented in this study explores how VEs that have emerged from the game design term juiciness can be applied and measured using a research game deployed in-the-wild. Findings show that in the context of a real world setting the juicy VEs in *Frogged Cubed* (screen shake and particle effects) have no effect on the length of a players first time play session or the frequency with which they return. this section discusses the the implications of the results in the context of previous work on juiciness and player psychological needs. Additionally a reflection upon the difficulties that games researchers face in deploying games in an in-the-wild setting in regards to player expectations, marketing, and data collection.

5.5.1 Juiciness and Motivation

While the findings in previous chapter found juiciness to increase factors that are linked with intrinsic motivation such as competence which should increase motivation for continued engagement, this chapter revealed that in voluntary play setting juiciness, may have little effect on a player's motivation to play a casual game. The previous chapter established that in a lab study setting, juiciness affects aspects of the player experience that may lead to positive FTU such as increased clarity of information and feelings of competence. However, this chapter finds that juiciness does not translate to increased engagement in an in-the-wild setting. The effect of juiciness on player experience could still be present in this setting, but the tricky balance between maintaining as true to real world experience as possible and needing richer data collection measures limits what can be found.

5.5.2 Difficulties for Research Games

Deploying a research game to the wild presents a new series of challenges that need to be addressed by researchers. When looking to measure effects in a voluntary game setting, a research game is competing with commercial entertainment games for the player's time. Due to this, a research game needs to provide a complete experience beyond that which is typically found in research games. *Frogged Cubed* is only a partially complete experience, while it features levels and difficulty increase, it is still missing aspects featured in similar commercial games such as leaderboards, narrative, and long-term goals. Overall, participants did not return to play, which is the strongest indicator that they did not find it engaging. With the increased number of games being released, researchers may need to now consider methods of promoting games similar to traditional games marketing. Lastly, there is a delicate balance between collected data as a research game and presenting the game as a entertainment product that needs to be considered e.g. adding a in-game questionnaire will yield richer data but at the cost of removing the voluntary play veil.

5.6 Limitations

There are several limitations presented in this work that need to be considered. The study has a small participant sample size when compared to other in-the-wild studies that report large participant samples [45, 44] although previous work has traditionally been partnered with the games industry. *Frogged Cubed* might not have been the best suited game for this study. While the game mechanics are based on the commercially successful game of *Frogger*, other aspects that comprise a commercial game are missing, e.g. player progression through things such as vanity items. *Crossy Road* is a commercially successful game where the core mechanic is based upon the mechanics of *Frogger* but features many of the elements missing in *Frogged Cubed*. The shallow nature of research games may be part of this concern, as research games that are deployed to the wild are competing with commercial games which offer a more complete coherent experience to the player with long-term and short-term goals. Future work in this area should look to explore this issue through designing more complete game experiences that feature common aspects traditionally absent in research games or when suitably leveraging existing commercial games.

5.7 Conclusion

This chapter explores the effects of juiciness on the FTU in the context of a voluntary play experience. An existing research game was deployed to the wild and analysed player metrics. The results reveal no effect on initial play time length or the likelihood to return to play, suggesting that the presented game did not have a sufficiently big motivational pull to engage players. This raises a question that games research needs to reflect on in general: are games developed for research studies engaging enough to also engage players when deployed in-the-wild, and what are implications for ecological validity?

Chapter 6

Juiciness and Gamification

Related Publication: K. Hicks, K. Gerling, G. Richardson, T. Pike, O. Burman, and P. Dickinson, 'Understanding the Effects of Gamification and Juiciness on Players', Proceedings of the 2019 IEEE Conference on Games, 2019.

In this thesis so far it has been established that applying elements of *juicy design* works as a way of increasing the player experience and visual appeal of games. This chapter presents a counterpoint to this through applying *juicy design* elements to an existing research tool that is not considered a game. This helps to provide a contrast to previous studies which found juiciness to have a positive effect on PX that it is worthwhile to see if this holds true for non-game experiences. Additionally, gamification elements were also added to compare applying juiciness to an existing approach using game elements outside the context of games. Gamification - the use of game elements in non-gaming settings to increase user engagement and improve performance [33] - is widely applied to transfer the motivational pull of games and increase user engagement with otherwise monotonous tasks [12]. While there is growing empirical evidence of the general effectiveness of gamification [135, 27], many studies only report small effect sizes (e.g., [26]) or omit further statistical analysis [135]. Additionally, our understanding of underlying mechanisms remains limited, with recent large-scale studies returning inconclusive results [135]. For example, Mekler et al. [97] found that the inclusion of badges, levels and leaderboards influenced user performance, but had no significant effect on perceived competence and intrinsic motivation. Taking a slightly different perspective, Sailer et al. [130] included a wider range of game elements and features (e.g., simulated teammates,

avatars, and narrative). Results show that aspects such as teammates do not only affect productivity, but also the underlying experience.

As the previous chapters have found juiciness also increases the overall player experience and has effects on factors that relate to the motivational pull of games, this chapter now looks at applying the motivational pull of juiciness in a research tool. Previous research on gamificaiton highlights it's potential to affect the same motivational pulls as juiciness [135, 130], suggesting that juiciness might serve as an alternative to gamification for improving user engagement. Yet, no existing empirical work has directly compared elements of juicy design and traditional approaches to gamification (i.e., badges, levels, and leaderboards) when applied in non-gaming settings.

This chapter investigates two elements 1) it explores the effects of juiciness on intrinsic motivation in a research tool 2) it compares the effects of gamification and juiciness on user experience, behaviour, and performance from the perspective of SDT [126]. This is done through the use of the simple virtual reality (VR) simulation Predator! [121], an application that was originally developed as a research tool to study human ability to track prey exhibiting different fleeing patterns. To understand effects of gamification and explore the impact of juiciness, two adapted versions of *Predator!* were created, which include gamification elements, juicy elements, and a combination of both. Results of a study with 36 participants show that traditional gamification and gamification achieved through juiciness both have positive effects on participants' experience, but that only juiciness offers a significant increase in perceived competence, suggesting that its effect are different from traditional gamification. Likewise, user preferences were in favour of the combination of both approaches, however, neither improved user performance.

The work presented in this chapter makes the following four main contributions: (1) provides the first empirical study of juiciness applied to a research tool, (2) provides the first structured comparison of juiciness and gamification, (3) provides empirical data that juiciness (both audio and visual aspects) has a positive effect on numerous

factors of the player experience and (4) provides details of the suitability of adding juicy elements to existing research tools.

6.1 Related Work

This section covers literature and previous work surrounding gamification and juiciness.

6.1.1 Gamification

The most widely accepted definition of gamification is provided by Deterding et al. [33], and refers to the *"use of design elements characteristic for games in non-game contexts."* While this definition in principle covers the application of various characteristics of games, gamification often narrowly focuses on the transfer of a small set of game elements thought to increase user motivation and performance, including points, badges, progression systems, leaderboards, and social comparisons [135]. To explain the effects of gamification on users, an increasing body of research draws from SDT [126]: SDT is a psychology-based methodology in-which humans are considered to be naturally intrinsically motivated when their base needs are satisfied, competence, autonomy, and relatedness. Ryan et al [129] apply SDT in the context of games and show that intrinsic motivation is a key factor in encouraging (re-)engagement with games. The theory has been applied in a number of gamification projects. For example, [42, 96] provide quantitative studies that employ SDT as a lens to examine the effects that specific gamification elements have on users, and Deterding [32] explores the relationship between autonomy and experience in a qualitative setting.

A growing body of research explores the effectiveness of gamification. Both Hamari et al. [56] and Seaborn and Fels [130] provide survey papers summarising evidence of effective application of gamification across a range of settings; for example, education, health, and crowd sourcing, but also criticise methodological weaknesses of many studies. More recently, large-scale studies exploring the effects of gamification

have returned inconclusive results. Trying to link "*traditional*" gamification elements to theoretical frameworks of motivation, Mekler et al. [97] study the effects of points, levels and leaderboards through the lens of SDT. While the study did find an impact of these gamification elements on performance, the authors did not find a significant increase in perceived competence and intrinsic motivation. In contrast, work by Sailer et al. [130] found a small effect of traditional gamification elements on competence, while non-traditional elements such as simulated teammates positively influenced aspects such as relatedness. Further research by Koivisto and Hamari [83] shows that positive effects of gamification decline over time, outlining an area of attention for future research.

6.1.2 Integration of Gamification and Juiciness in VR

There is little work that has explored the application of juiciness to VR. Relevant work studying how gamification can be leveraged to increase engagement with VR simulations strongly focuses on healthcare settings; for example, to treat arachnophobia [99], and to train users in the use of hearing aids [109]. Results suggest that gamified VR simulations are an effective means of providing therapy and to engage users. However, the studies did not differentiate between traditional VR simulations and gamified versions, therefore not providing insights into added benefits of gamification and confounding factors such as the novelty of the VR experience.

This chapter addresses the gap in wider perspectives on gamification through implementation of juicy elements, along with those of traditional gamification, allowing us to study their effects on user performance, behaviour, motivation, and experience. This is motivated by the observation that juicy elements may be better aligned with intrinsic motivators, and thus complement traditional approaches toward gamification.

6.2 Predator!: A VR System to Study Gamification and Juiciness

The VR simulation *Predator!* is a system used by researchers in animal behaviour at the University of Lincoln to investigate the efficacy of different real-world prey escape behaviours [121], and has previously been applied in experiments in this field. Given the relatively simple nature of the tool, it offers an ideal test bed for further research. *Predator!* usage of VR is motivated through its application as a life science tool for exploring fleeing behaviour. Here, the design of the simulation, and how gamification and juicy elements were integrated to complement the existing system are presented.

6.2.1 Original Design

Predator! simulates the task of targeting a moving prey animal in a 3D simulation, which is presented to participants using a Samsung Gear VR Head Mounted Display (HMD). The system uses a simulated prey object, and the targeting process is implemented in a way that is analogous to aligning the prey with the predator's head or body prior to attack (or similar to targeting the prey with a weapon, in the case of a human predator).

User Input

Participants undertake a number of trials, each lasting several seconds: they are asked to target (as best as possible) a moving sphere, which represents the prey. Targeting is achieved using a reticle in the centre of the display, and participants need to move their head to align the reticle with the prey as accurately as they can, while it is moving. The prey changes direction and speed (sometimes with high frequency), to confound the targeting process. The ability of the target to evade predation is evaluated using various metrics computed over the course of each trial. Participants perform the task while seated, and receive training in use of

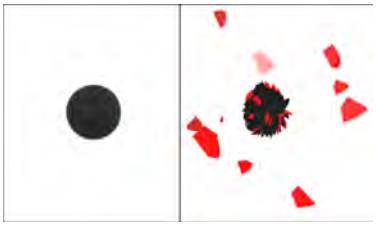

Figure 6.1: Visible is the basic (left) and juicy right versions of the prey ball.

the equipment, and in targeting the object, prior to undertaking the experimental conditions.

Fleeing Behaviour

The simulation parameters used for this work replicate a study previously performed by Richardson et al [121]. The prey sphere is drawn using a dark colour on a white background to maximise contrast (see Figure 6.1). Two fleeing behaviours are compared: a "fixed" fleeing behaviour and a "Protean" behaviour which mimics the movements of certain species [68]. Using the fixed pattern, the prey sphere uses fixed values of turn angle, speed, and frequency of direction change, to define its movement. Protean behaviour uses randomised values, which create more variation and typically confuse predators which try to anticipate prey behaviour. Both fleeing patterns are applied in random order.

Feedback Provision

The original simulation includes basic feedback that informs users about the state of the world. Important events (e.g., acquiring the prey) are underlined using simple visual highlights (i.e., briefly changing colour to highlight event); performance feedback is provided implicitly by visualising the position of the reticle relative to the prey.

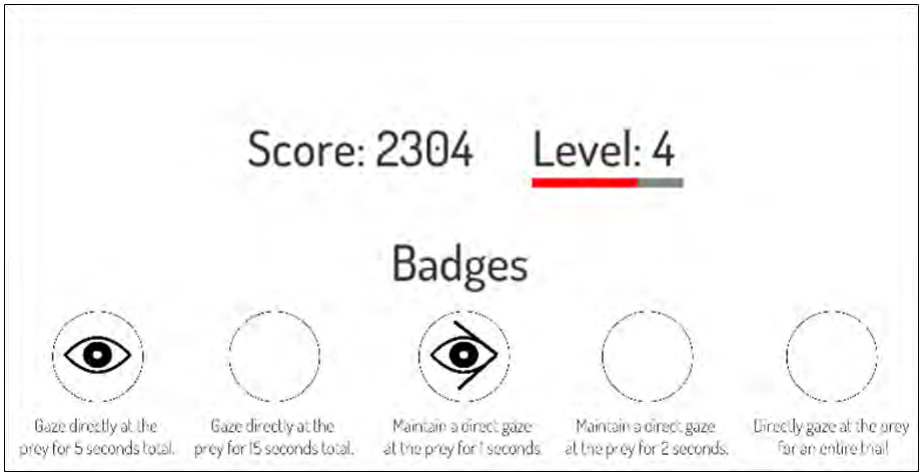

Figure 6.2: Presentation of the gamification elements.

Gamification Elements

Gamification has previously been leveraged to increase engagement in a variety of settings, inspired by this work and based on gamification literature [135], selected were four commonly used gamification elements, a scoring system, badges, leaderboards, and progression (see Figure 6.2).

Scoring System. The base version of the game gave no indicators to the users of how well they were doing. The gamification version includes the display of a high score that increments when the user's gaze meets the prey, along with a multiplier for maintained contact.

Achievement Badges. Badges were added which can be awarded for a number of achievements for example, completion of five tasks, or maintaining gaze contact with the prey for a certain number of seconds (5 seconds and 15 seconds).

Progression System. A progressions system was added to the simulation which is based on levels; users are awarded points that translate into levels as they progress through the simulation.

Leaderboard. Users are presented with a leaderboard that displays their score in relation to other, simulated users. High scores are adapted to situate the user between rank three and five to minimise effects on player experience [13].

Figure 6.3: A visual break down of the juicy elements that are displayed when the player establishes gaze over the prey in sequential order.

Juicy Elements

Drawing from previous work on juiciness [78], selected were four elements of juicy design that support the idea of continuous and abundant audiovisual feedback (see Figure 6.3 for visual feedback elements).

Animation Effect. An animation effect was added to the prey ball made out of meshes to give the illusion that the ball is furry and a tangible object.

Particle Effect. An animation effect appears when the user initially places their gaze on the prey. The effect spawns around the prey to avoid occlusion of critical information.

Dynamic Soundtrack. A dynamic soundtrack that is upbeat and pleasant plays with the volume fading based on proximity of the user's gaze to the prey. If they are gazing directly it is full volume, if they are further than the radius of the prey away the music can not be heard.

Sound Effect. A sound effect is played when the user initially places their gaze on the prey. The pitch changes if users rapidly lose and re-gain control of the prey.

Using both the gamification and the juicy elements, four versions of *Predator!* were created: the original simulation with basic feedback, a gamified version, a juicy version, and a combined version including gamification and juicy elements.

6.3 Study: Understanding the Effects of Gamification and Juiciness

This section presents a study that explores the effects of gamification and juiciness using the simulation *Predator!*. In a within-subjects study with four conditions, the study explores how gamified, juicy, and a version including gamification and juicy elements (Combined condition) compare to the standard version of the simulation with regular feedback (Base condition).

6.3.1 Research Questions

This study aims to address three research questions investigating the effects of gamification and juiciness, and how the approaches are perceived by users.

RQ1: Do gamification and juiciness have an impact on user experience and motivation? Previous work has provided evidence that gamification is an effective means of improving user experience, and literature on juiciness outlines its potential to influence intrinsic motivation through increased competence. This led to the following hypotheses:

H1a: Gamification improve user experience.

H1b: Juiciness improve user experience.

H1c: Juiciness improves perceived competence and increases intrinsic motivation.

RQ2: Do gamification and juiciness influence user performance and behaviour? Both approaches incorporate elements to encourage user engagement with the core task, and offer additional feedback on performance. However, these amendments to the base version of the simulation could also influence how users act. For example, badges might encourage participants to focus on the accomplishment of related tasks, whereas the nature of juicy design might encourage behaviours that trigger feedback, e.g., re-acquiring the prey.

H2a: Gamification and juiciness increase user performance.

H2b: Gamification will lead to improved metrics that are reflected through badges (maximum time gazed at prey).

H2c: Juiciness will lead to increased participant attempts to trigger feedback (re-acquisition of the prey).

RQ3: Are there differences in the objective effects and perceived benefits of juiciness and gamification? Elements of gamification and juiciness are visible to users and change the appearance of the system to resemble that of a game, possibly increasing its appeal. Therefore it is hypothesised:

H3: Gamification and juiciness improve user perspectives on the simulation; the combination yields best results.

6.3.2 Measures

Questionnaires

Two standardised questionnaires were used to measure the player experience, the PENS questionnaire and the Intrinsic Motivation Inventory (IMI) [24]. The PENS is based on SDT [126, 129] and includes sub-scales for Competence, Autonomy, Presence, Relatedness, and Intuitive Controls. Participants are asked to rate statements such as "I feel competent at the game" on a 7-point Likert scale. The IMI focuses on intrinsic motivation; the version included in this study features three sub-scales, Interest/Enjoyment, Competence, and Tension. Participants are asked to rate statements such as "I felt pretty skilled at this task" on a 7-point Likert scale. Both questionnaires have previously been applied in Games User Research and studies focusing on gamification (e.g, [97, 130]), demonstrating their suitability in interactive settings. Additionally, an exit questionnaire was employed that asked participants to rank conditions in order of preference, rate the enjoyment of each condition on a 7-point scale, and comment on their preferences.

Performance Metrics

The simulation *Predator!* was originally developed to monitor how well humans can track fleeing behaviours of prey. The original simulation operationalised performance through the average distance of the user's gaze from the prey. Distance is calculated from the Cartesian coordinates of the prey in 3D space, and the orientation of the player's head, recorded every 0.02 seconds. The minimum 3D distance between the two is calculated using a ray cast from the head of the player to the centre of the prey. This metric is adopted as the key measure of performance, along with the score (only displayed in gamified conditions, but recorded for all). Furthermore, the longest duration the participant held their gaze directly on the prey was recorded as an aspect of player behaviour that directly relates to gamification elements (e.g., badges rewarding gaze duration). Also included was the number of times the prey was acquired by directly gazing at it as a measure of the impact of juicy design on behaviour as the acquisition of the prey results in audiovisual feedback.

6.3.3 Participants and Procedure

36 participants were recruited (17 male, average age 26, SD=5.8) through mailing lists and social media sites. Nine Participants had no previous experience using VR, and none of the participants reported colour vision deficiency. Each session lasted about 45 minutes. At the start of the study, each participant provided informed consent and was briefed that they will be playing a prey catching game and how to play. Afterwards, participants were given brief background information on *Predator!* as a research tool for the life sciences. When participants first put on the VR HMD, they were shown instructions to help focus and ensure the headset was comfortable, and they were also given the chance to practice on a trial task until they felt ready to proceed whilst being guided by the investigator. The remainder of the study was split into four sequences consisting of one of the conditions (*Base, Juicy, Gamified, Combined*) of Predator! followed by questionnaires on player experience and motivation. Conditions were counterbalanced using a Latin square to control for

Figure 6.4: A user using the system whilst sitting down in the study environment.

order effects. Participants were asked to immediately report simulator sickness, and answered the Simulator Sickness Questionnaire (SSQ) [81] with results showing no instances of sickness. At the end of the study, participants were asked to complete a final questionnaire on their experience, and to provide demographic information. Afterwards, participants were given an opportunity to ask questions relating to the conditions and research. See Figure 6.4 for an example study scenario. The research protocol was approved by the ethics board at the University of Lincoln, UK.

6.3.4 Data Analysis

Data were analysed in SPSS V22. RM-ANOVAs were applied for questionnaire data (PENS and IMI) and performance data using condition as within-subjects factor. If sphericity was violated, Huynh-Feldt correction was applied; pairwise comparisons were made with Bonferroni correction. Preferences were analysed using Friedman's Analysis of Variance, pairwise comparisons were made using Wilcoxon Signed Rank tests.

6.3.5 Results

Here, the results are organised by research questions. Reported are quantitative results and further explain findings using qualitative participant feedback.

Table 6.1: Average scores for the PENS and IMI (7-point Likert scale) for each condition.

		Standard	Juicy	Gamification	Combined	Significance
PENS	**Competence**	3.84(1.71)	4.84(1.57)	4.24(1.71)	4.4(1.51)	$F3, 105 = 4.618$, $p = .004$, $\eta^2 = .117$*
	Autonomy	3.04(1.36)	3.89(1.39)	4.11(1.45)	4.09(1.57)	$F3, 105 = 8.475$, $p = .000$, $\eta^2 = .195$*
	Relatedness	1.89(1.05)	2.42(1.33)	2.30(1.2)	2.44(1.30)	$F3, 105 = 4.258$, $p = .007$, $\eta^2 = .108$*
	Presence	2.29(.83)	3.04(.87)	2.9(1.01)	3.0(1.04)	$F3, 105 = 8.215$, $p = .000$, $\eta^2 = .190$*
	Int. Controls	6.4(.83)	6.56(.56)	6.55(.77)	6.7(.5)	$F3, 105 = 2.262$, $p = .099$, $\eta^2 = .061$
PXI	**Interest/Enjoyment**	3.86(1.33)	4.94(1.20)	4.74(1.23)	5.03(1.18)	$F3, 105 = 13.076$, $p = .000$, $\eta^2 = .272$*
	Perceived Competence	3.52(1.55)	4.61(1.44)	4.08(1.44)	4.12(1.44)	$F3, 105 = 6.739$, $p = .000$, $\eta^2 = .161$*
	Perceived Choice	5.85(1.07)	5.87(.84)	5.83(2.47)	5.87(1.12)	$F3, 105 = .028$, $p = .993$, $\eta^2 = .001$
	Pressure/Tension	2.61(1.21)	2.29(.99)	2.47(1.3)	2.50(1.20)	$F3, 105 = .892$, $p = .430$, $\eta^2 = .025$

RQ1: Do Gamification and Juiciness have an impact on user experience and motivation?

Yes. The results show that the Juicy, Gamified and Combined conditions of the study provided a significantly better user experience than the Base version of the simulation, and also resulted in significantly higher levels of user motivation (see Table 6.1 for descriptives).

Player experience. There was a main effect of condition on Competence ($F_{3,105} = 4.618$, $p = .004$, $\eta^2 = .117$). Pairwise comparisons showed that juicy elements increased competence ($p = .002$), but that Gamification ($p = .723$) and the Combined version ($p = .336$) did not contribute to participants' perception of competence when compared to the Base version. A main effect of condition was found on Autonomy ($F_{3,105} = 8.475$, $p = .000$, $\eta^2 = .195$). Pairwise comparisons showed that the Juicy ($p = .005$), Gamified ($p = .000$) and Combined versions ($p = .002$) all significantly contributed to perceived autonomy, but none of these versions outperformed each other (all $p = 1.000$). Further, there was a main effect of condition on Relatedness ($F_{3,105} = 4.258$, $p = .007$, $\eta^2 = .108$). Pairwise comparisons showed that the Juicy ($p = .018$) and Combined versions ($p = .023$) significantly improved Relatedness, but that there was no difference between them ($p = 1.000$). Additionally, a main effect of condition on Presence ($F_{3,105} = 8.215$, $p = .000$, $\eta^2 = .190$) was found. Pairwise comparisons showed that the Juicy ($p = .000$), Gamified ($p = .000$) and Combined versions ($p = .003$) all significantly increased presence, but none of these versions outperformed each other (all $p = 1.000$). Finally, there was no significant main effect of condition on Intuitive Controls ($F_{3,105} = 2.262$, $p = .099$, $\eta^2 = .061$),

suggesting that the control scheme was perceived as comparable across conditions. These results support H1a.

Intrinsic motivation. There was a main effect of condition on Interest/Enjoyment ($F_{3,105} = 13.076$, $p = .000$, $\eta^2 = .272$). Pairwise comparisons showed that the Juicy ($p = .000$), Gamified ($p = .001$) and Combined versions ($p = .000$) all significantly increased interest/enjoyment, but there were no significant differences between them (all $p = 1.000$). Further, there was a main effect of condition on Competence ($F_{3,105} = 6.739$, $p = .000$, $\eta^2 = .161$). Pairwise comparisons showed that juicy elements increased competence ($p = .000$), but that Gamification ($p = .259$) and the Combined version ($p = .379$) had no effect when compared to the base version. This result supports H1b. Finally, there was no significant main effect of condition on Choice ($F_{3,105} = .028$, $p = .993$, $\eta^2 = .001$) and Tension ($F_{3,105} = .892$, $p = .430$, $\eta^2 = .025$).

RQ2: Do Gamification and Juiciness influence user performance and behaviour?

Only in some instances. the results show that there is no effect of Gamification, Juiciness or the Combined version on the original performance metric. However, results do show that the maximum time spent gazing directly at the prey was lowest in the Juicy and Combined conditions, suggesting that Juicy elements can have an impact on player behaviour that in turn affects performance metrics.

There was no significant main effect of condition on average distance from the prey ($F_{2.4,84.24} = .107$, $p = .928$, $\eta^2 = .003$; $M_{\text{Base}} = 0.46$, $SD_{Base} = 0.66$, $M_{\text{Juicy}} = 0.48$, $SD_{\text{Juicy}} = 0.66$, $M_{\text{Gamified}} = 0.48$, $SD_{\text{Gamified}} = 0.77$, $M_{\text{Combined}} = 0.49$, $SD_{\text{Combined}} = 0.83$), the performance metric applied in the original animal behaviour study. Therefore, H2a cannot be confirmed. However, there was a main effect of condition on the maximum time that participants spent holding a direct gaze on the prey ($F_{2.373,83} = 3.4$, $p = .032$, $\eta^2 = .088$). Pairwise comparisons showed that the Juicy condition significantly decreased time spent over prey when compared to the Base ($p = .044$) and Gamification ($p = .003$). In the Combined version, participants also

spent significantly less time directly gazing at the prey when compared against the Base version ($p = .034$). This directly contradicts H2b suggesting that the Gamified condition increases maximum time spent gazing at the prey; instead, the inclusion of juicy elements reduces the time spent gazing at the prey compared to the other conditions. This is also reflected in the score calculated based on these values; there was a significant main effect of condition on score ($F_{3,105} = 3.964$, $p = .010$, $\eta^2 = .102$; $M_{\text{Base}} = 9673$, $SD_{\text{Base}} = 4036$, $M_{\text{Juicy}} = 9006$, $SD_{\text{Juicy}} = 3161$, $M_{\text{Gamified}} = 10559$, $SD_{\text{Gamified}} = 4525$, $M_{\text{Combined}} = 9346$, $SD_{\text{Combined}} = 3269$). Pairwise comparisons show no significant difference was between Base and Juicy ($p = .196$), Gamification and Base ($p = .077$), and Combined version and Base ($p = .442$). However, participants scored significantly higher in the Gamified condition when compared to both the Juicy ($p = .001$) and Combined ($p = .019$) versions. Finally, there was no significant differences regarding the amount of times users re-acquired prey ($F_{2.41,84.45} = .986$, $p = .390$, $\eta^2 = .027$). Thus, H2c cannot be supported.

RQ3: Are there differences in the objective effects and perceived benefits of juiciness and Gamification?

Yes. Results for perceived enjoyment and overall preference of condition (version of the simulation) suggest that subjective preference was highest for the Combined version featuring both juicy and gamification elements, and that the Juicy version was preferred to the Gamified version. However, qualitative feedback does not just highlight benefits of juiciness but also suggests that participants appreciated traditional gamification.

Perceived enjoyment. There was a main effect of condition on perceived enjoyment ($F_{2.72,95.29} = 53$, $p = .000$, $\eta^2 = .602$). Pairwise comparisons revealed that all conditions were rated significantly different from each other. The Combined version was rated significantly higher than Base ($p = .000$), Juicy ($p = .001$) and, Gamification ($p = .000$). Further, the Juicy version was rated significantly higher than both the Base ($p = .000$) and, Gamification ($p = .000$) versions. Lastly, Gamification was

Table 6.2: Average ratings and SD for enjoyment (1=not at all, 7=very much) and condition preference rankings (median value).

	Enjoyment	**Ranking**
Base	2.81(1.61)	4.00
Juicy	5.58(1.13)	2.00
Gamification	4.64(1.55)	3.00
Combined	6.28(0.77)	1.00

rated significantly higher than the Base ($p = .000$) version. These results support H3.

Preference. There was a main effect of condition on preference ranking order ($\chi^2(2) = 67.9$, $p = .000$). Pairwise comparisons revealed that all conditions were ranked significantly different from each other. The Combined version was rated significantly higher than all three conditions (Base $Z = -5.34$, $p = .000$, Juicy $Z = -3.26$, $p = .001$, Gamified $Z = -4.66$, $p = .000$). The Juicy condition was rated significantly higher than both Base ($Z = -5.21$, $p = .000$) and Gamified ($Z = -2.45$, $p = .014$) conditions. Lastly, Gamification was rated significantly higher than Base ($Z = -3.75$, $p = .000$). These results also support *H3*.

6.3.6 Summary of Results

Finally, qualitative feedback further elaborates on participant preferences and ratings. Regarding juicy design, participants reported that associated elements increased feelings of engagement. For example, one participant stated that *"I liked the music it made the game a lot more exciting and engaging."* Some participants also commented on how juicy elements made the prey more relatable, e.g., outlining that *"I appreciated the furry ball it felt more alive."* When commenting on Gamification elements, participants reported enjoying the goal orientated nature that badges provided, e.g., *"Getting to see what badges you can get to challenge myself."* Gamification elements were also found to be motivating, e.g., one participant stated that *"The score and badges encouraged me to play more."* Further, feedback that the elements provided was also observed by participants: *"The feedback supplied helped gain an understanding of what I was doing."* Finally, participants enjoyed the combina-

tion of the elements as it helped foster feelings of engagement, for example, *"The combined elements made the game more engaging and enjoyable."*

6.4 Discussion

The work presented in this chapter examines the effects of traditional gamification and gamification implemented by means of juicy design. Additionally, this chapter has explored the effects of applying juiciness; a design term previously only applied to games to a research tool. This section discusses the implications of the findings with a focus on differences between gamification and juiciness, and challenges and opportunities regarding their implementation.

6.4.1 Effects of Gamification and Juicy Design in Simple VR

The results show that traditional gamification and juicy design both offer effective means of improving user experience particularly when asking users to engage with otherwise simplistic but challenging task in a VR setting.

Effects on User Performance and Behaviour

Neither gamification nor juiciness led to significant increases in performance. This result needs to be interpreted in the light of the given task and the fidelity of the environment: tracking fleeing behaviour of a virtual object, and asking individuals to operate at the fringes of their abilities, possibly leaving little room for improvement. Additionally, the results show that juiciness affected participant behaviour (shorter maximum time that gaze was held directly on the prey), whereas gamification had no impact. This difference may be a result of additional visual feedback that is displayed around the prey and on its acquisition in conditions with juicy elements, possibly introducing a source of distraction. This aspect highlights a core challenge in the employment of juiciness: elements need to be chosen in a way that they do not

act as a confound. For example, if a task is predominantly visual, graphical effects can be problematic, and alternatives such as audio feedback need to be considered.

User Preferences: Gamification vs Game

Beyond the direct effects of both approaches, findings reveal that the Combined (gamified and juicy) version received the highest preference ratings. This hints at an interesting dilemma: the combined version arguably did not just integrate two approaches toward the transfer of game elements into non-gaming settings, but also most closely resembled an actual game due to the number of game elements that were integrated. Researchers and designers wishing to employ gamification and related approaches therefore need to answer two questions: What is the minimum number of game elements required to meet the threshold for positive user feedback in a given scenario, and when does a gamified system become a game - a question that becomes increasingly relevant as the boundaries between gamified systems and games shift.

Impact of the VR Environment

Finally, it is important to consider the impact of the VR environment. This study was done using a simulation environment designed for life sciences research; the simplicity of the environment clearly exposed elements of gamification and juicy design, and in applications that are more complex (both in terms of tasks and visual design) achieving an impact of juicy design might be more challenging. To address this issue, future work should explore how juicy design compares to gamification both in more complex VR environments, but also in non-VR settings.

6.4.2 Gamification, Juiciness, and Self-Determination Theory

Previous work suggests a relationship between gamification and intrinsic motivation that requires careful selection of game elements, with some studies suggesting it

neither has positive nor detrimental effects [97], and others showing that a broad range of elements (e.g., badges, leaderboards and social avatars) should be applied to achieve improvements in all aspects (competence, autonomy, relatedness) [130]. In this context, these results demonstrate that simple juicy elements have clear benefits for perceived competence, autonomy, and relatedness (in turn increasing intrinsic motivation) in the given setting, suggesting that this approach may be leveraged as a design alternative to traditional gamification. This is in line with previous research on SDT [24], demonstrating that tangible rewards decrease intrinsic motivation, whereas feedback that emphasises competence while maintaining autonomy has a positive impact on intrinsic motivation.

6.4.3 Back to the Roots of Gamification

These findings suggest that a need to reconsider the pervasive perspective on gamification that exclusively focuses on elements such as badges, levels, and leaderboards. Bringing the concept back to the original definition that considered any application of game elements in a non-gaming context to be gamification [33], and responds to recent criticisms that call for a focus on gameful experiences [31]. The results offer an opportunity for researchers and designers wishing to apply gamification: 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. It may be worth considering explicitly incorporating juiciness in the definition of gamification as an approach that leverages the application of game elements in non-gaming settings. Therefore, gamification encompasses performance-centred aspects (traditional gamification elements such as leaderboards and levels), but also includes experience-centred design elements (juicy elements including immediate audiovisual feedback).

6.5 Limitations

There are some limitations that need to be considered when interpreting the work presented in this chapter. Firstly, the study was carried out using a simplistic VR simulation; while it offered an ideal test bed for an initial study, further research is necessary to extend the findings to other settings. Additionally, studies involving more complex tasks and implementing different VR systems are necessary to ensure that findings can be generalised. Finally, results reported in this chapter were obtained through a single-session lab study.

6.6 Conclusion

This chapter has explored the effects of gamification and juiciness in a research tool. Results show that both gamification and juiciness can be effective means of delivering a positive user experience, but that in the context of this study, only juiciness significantly improves the three basic psychological needs for competence, autonomy and relatedness, in turn facilitating intrinsic motivation. These findings have implications for perspectives on gamification, suggesting that designers should refocus on the development of a wider, experience-centred toolbox that move beyond the application of traditional gamification elements (as provided by [31]), and equips researchers and designers with broader means of creating engaging playful experiences.

Chapter 7

Main Findings

A description of the main findings presented in this thesis is given in this chapter. The goal of this chapter is to highlight the outcomes of each user-study presented, and focusing on the overarching key knowledge contributions of the work.

7.1 Defining Juiciness

Chapter 3 looks at how juiciness was constructed in literature, and used this as a basis for surveying game designers on their perspectives of juiciness. These perspectives were analysed using an affinity diagram approach. The results show that juiciness is used by designers as designer shorthand for describing the feel of the game with regards to feedback mechanisms and cohesiveness of game elements. It was also found that designers considered juiciness as a tool used to reach the important goal of creating games which feel positive, but they acknowledge that it is difficult to describe and define. This chapter contributes further to our understanding of how game designers perceive juiciness and how it manifests in games.

7.1.1 Juiciness Definition

The key finding from Chapter 3 is the first empirically grounded definition of juiciness:

Juiciness is a term that describes a game experience that contains a coherent design of game mechanics and visuals, while providing feedback to the player with both direct

feedback that is confirmatory, relevant and explicit, but also offering superfluous feedback that helps to inform players about the game state, and contribute to the game being perceived as a coherent whole.

The key component of this definition is that it captures how juiciness extends beyond just providing superfluous feedback, and categorises the type of feedback necessary for a game to feel juicy. This definition also recognises that the non-feedback elements of a game need to be coherent: it is not enough to just add feedback elements to make a game juicy if the underlying experience is not well designed. This definition is considered a working definition: as it is the result of the first empirically grounded investigation into juiciness, there may still be aspects not captured by this definition which need to be teased out through more detailed future research.

7.1.2 Juicy Analysis Framework

Additionally, a main finding of Chapter 3 contributes a framework for analysis that can serve as a tool to evaluate complete games or games under development to highlight areas where elements of juiciness such as explicit feedback are being met by the game or missed 7.1. This tool has been evaluated throughout this thesis being used as an approach for evaluating the research games presented in Chapters 4,5, and 6. Please note that framework usage is aimed at analysing games, but does not provide any guidance or specific advice with regards to how to achieve and or implement juiciness.

7.2 Studying Juiciness

Chapter 4 explores the effects of juiciness on player experience through a series of structured user studies studying the effects of juiciness in both bespoke research games and in a commercial game. The findings from these studies revealed that juiciness can impact and change the player experience. For example, it was found that juiciness can target certain aspects of the experience linked to intrinsic motivation,

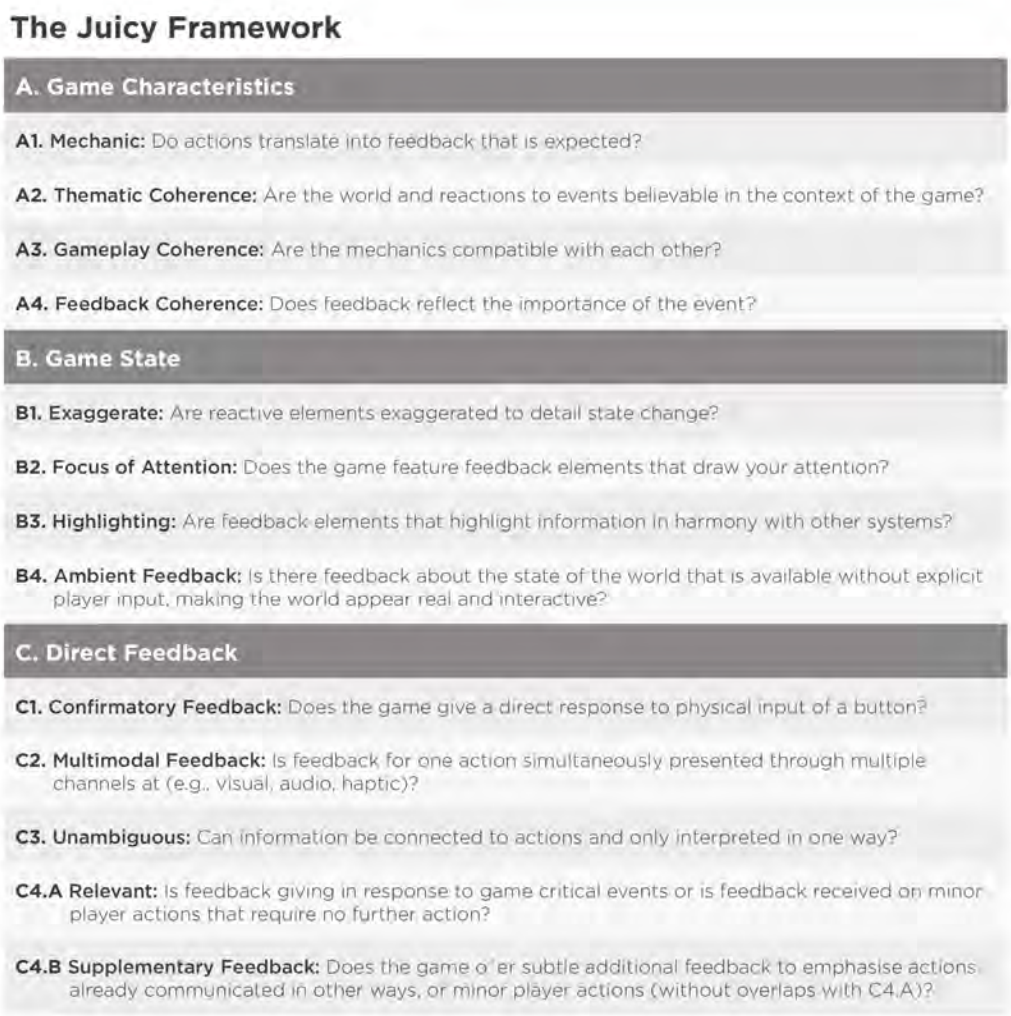

Figure 7.1: The finalised version of the juicy analysis framework tool.

such as competence and presence. The visual aspects of juiciness that were explored found that they also positively affect how the player perceives the visual design of the game. These studies have contributed to our understanding of how juiciness, depending on design, context, and implementation, can positively affect all aspects of intrinsic motivation while also increasing the visual appeal and hedonic qualities of the experience. These findings contribute to an ever growing area of research that explores the impact of juiciness on players, and also provides a detailed study structure to be replicated by future researchers to evaluate further aspects of juiciness in the future.

7.3 Juiciness in-the-wild

Lastly, Chapter 5 presents a user study that looks at juiciness from the slightly different angle of FTU and engagement, hypothesising that since juiciness affects factors of intrinsic motivation that it could also impact the FTU with regards to how long they play. This was done through deploying *Frogged Cubed* in-the-wild, and using player metrics to measure FTU. The findings revealed that juiciness in this context did not have an impact on FTU. However, the contribution from this chapter lies more in the structure of running an in-the-wild study and the lessons learned from deploying a bespoke research game in-the-wild. This chapter contributes towards discussions around the deployment of research games, and presents guidance aimed at future researchers for the deployment of research games in uncontrolled settings.

7.4 Juiciness and Gamification

The work in Chapter 6 presents a comparison study of juiciness and gamification to investigate how the two approaches impact player experience, and if there is potential for them to be combined. This was done by modifying an existing research game, creating versions that include juicy elements, gamification, and a combination of both juicy and gamification elements. The game was then used in a user study

building on the methodology and results from the previous chapter. The findings from this study showed that juiciness can be an effective approach for inducing an improved player experience, and when compared to gamification can affect different factors of the player experience. The core contribution from this chapter is the finding that juiciness and gamification provide comparable contributions to the overall player experience, proving that juiciness may be a suitable alternative to gamification when looking to leverage the motivational pull of game elements. These results contribute towards our perspectives on gamification and juiciness, indicating that designers can make use of game elements that go beyond the use of conventional gamification components (i.e., badges, leaderboards, etc.) to achieve user engagement, and equips researchers and designers with wider means of creating engaging playful experiences that also include the tools offered by juiciness.

7.5 Summary

This chapter has provided a summary of the studies presented in this thesis, highlighting each of their key contributions. The next chapter will discuss the wider implications of these findings.

Chapter 8

Wider Implications of Juiciness

While each of the previous chapters discussed the results of the work in its own context, this chapter delves into the wider implications of the findings, bringing all the results together to provide a basis for reflecting upon the construct of juiciness.

This thesis presents a range of user studies of juiciness in several different contexts; research games, purpose designed games, a commercial game, and lastly a game that was deployed in-the-wild. The main finding from these studies revealed that VEs across several genres of games explored can have a large positive effect on a player's intrinsic motivators but the context of the visual embellishment is important. The first chapter of this thesis summarised the existing literature on both juiciness and VEs, highlighting that our understanding of VEs falls in line with the visual aspect of juiciness. From this overview, two main issues were highlighted that need to be addressed. (1) Juiciness is a vague and loosely defined concept that needs a tangible empirically grounded definition in order to be further explored by researchers; (2) the existing research points towards juiciness having an effect on intrinsic motivators to increase player experience, but has not been explored in depth. In the remainder of the thesis, these issues were addressed, and several research questions that were derived in the beginning of this work have been answered through the development of research games, and in the context of different user studies. The first study was designed to create an empirically grounded definition of juiciness through the creation of a framework that would be actionable by both designers and researchers. This study showed that designers had an innate understand of juiciness, revealing that juiciness is more than just superfluous feedback elements. The second study presents

the first empirical evaluation of the effects that juiciness can have when applied to research games, showing that juiciness can broadly affect the visual appeal of games, and can affect some aspects of the player experience such as meaning. The third study builds on the findings of the second study through applying juiciness to an existing commercial game and demonstrates that in some circumstances aspects of the player experience such as competence can also be improved through juiciness. The fourth study investigates juiciness in-a-wild setting through deploying a game digitally and exploring first time engagement. Lastly, the fifth and final study broadens our understanding of juiciness through applying it to a research tool and comparing the effects of juiciness with those of gamification, showing that it can fulfil all basic psychological motivational needs where gamification only meets several.

When evaluated in the lab setting both of the research games *Frogged Cubed* and *Dungeon Descent* had an increased positive player experience in the conditions where the VEs were present, although the construct of player competence was not significantly increased in these research games. It was expected that juiciness would have an effect on perceived player competence based on the existing literature frequently tying competence and juiciness together [77, 78, 133, 31]. However, when investigating juiciness (constructed as VEs) in a commercial game setting using *Quake III*, the results show that VEs affect the same factors found through the research games, however, it also revealed that perceived competence increased with the presence of VEs. These findings highlight that it is not as simple as adding VEs to game to increase competence, instead care and consideration should be taken when implementing juiciness depending on what aspects of the player experience are being targeted.

On a general level, the findings presented in this thesis reveal that juiciness can be successfully conceptualised and applied in both research and entertainment contexts to improve the player experience, visual attractiveness, and player preference of games. Although, the results also shine a light on the issue of applying VEs as an abstract part of juiciness, both in the nature of application but also in that most of the studies presented did not explore the effect of audio embellishments fully, which has been briefly discussed in previous literature as an important aspect [31, 133].

The effects that have been found could potentially be further enhanced through the additional of audio embellishments on top of visual. The approach of exploring the effects of juiciness on player experience through the lens of SDT was a suitable approach for my thesis work, however not the only one. It would be interesting to explore juiciness from a different theoretical angle in the future such as approaching it from a media theory e.g. surrogate body [140] to see how it compares to the psychological approach this thesis took.

Building on these findings, this chapter seeks to provide overarching answers to the core research questions raised in the introduction. It discusses the relationship between VEs and juiciness, and reflects on the wider implications of for juicy design to support researchers and practitioners wishing to formally integrate the concept in their projects. It also outlines how these findings are relevant for game development.

8.1 How can we define juiciness in the context of games, and which game elements contribute to it?

According to game developers, juiciness can be defined broadly as a collection of game elements that constitute to making the game feel pleasurable to play. This research question was answered by surveying game developers on their perspectives on how they define juiciness in their practice, and what effect it had on games. This was done in addition to reviewing all relevant academic literature to help form a robust definition of juiciness. Previous literature focused predominantly on juiciness as designer shorthand for adding more feedback elements to a game, however, from the analysis presented it is clear that developers have a deeper understanding of juiciness that moves beyond mere feedback. Juiciness refers to aspects that contribute to the game as a whole, guiding the design of the context of feedback rather than the previous understanding of just adding more feedback; for example, it is not enough to just add multiple feedback elements while neglecting other elements of the game such

as the communication of the game state and game characteristics such as thematic coherence (reactions to events should be believable in the context of the game). This means that the game needs mechanically to feel "slick" to play, all elements need to be cohesive with each other and the state of the game should be communicated to the player constantly regardless of input.

The framework lays out the different elements that developers believe contribute to making a game feel juicy, broken down into three categories; Game Characteristics, Game State, and Direct Feedback. Game Characteristics details how in order for a game to be juicy the mechanics need to translate into feedback that the player expects while the also making sure to keep elements such as mechanics and theme coherent with one another. Game State deals with how the game, through feedback elements, needs to convey the current state of the game to the player; this is done through including feedback that is exaggerated to detail state change. To convey game state the game also needs to include feedback that is highlighting in nature, bringing player awareness of information in harmony with other systems, while also making sure to include some feedback that draws attention to game critical events at the expense of other game elements. The last feedback type that developers highlighted conveyed the game state was ambient in nature, it does not have to directly react to a play action but instead is feedback that is delivered when something in game has changed without input from player, e.g., In *The Legend of Zelda: Breath of the Wild* when the time of day changes into nighttime (more dangerous) the game informs the player through multiple ambient feedback elements. Lastly, the framework details the Direct Feedback elements that explicitly define the feedback a game should provide. Key to this is confirmatory feedback; any physical input from the player should have a direct in-game response. Feedback should be presented on all available channels (visual, audio, haptic) and should be unambiguous; the player should know if the feedback they received is positive or negative. All of these aspects need to be considered according to developers when striving to create juicy experiences.

This insight into how game developers perceive juiciness highlights that the process of making a game juicy is significantly more complex than previous literat-

ure would suggest, with developers detailing many more aspects than just adding "*more positive feedback*" [133]. However, this more complex definition has highlighted that many of the elements that game developers considered contribute to juiciness are also considered standard elements of good game design. Several aspects of the framework presented in this thesis detail ensuring meaning and agency is felt by the player through appropriate feedback; existing literature has also highlighted that good game design will ensure that play is meaningful through creating a sense of agency [131]. Direct feedback as defined in the juicy framework is also understood by both academics [133] and industry [142] as a crucial part in marking a game feel good to play, again presenting an overlap with our understanding of juiciness. Björk and Holopainen presented the pattern of thematic consistency in their work exploring patterns in game design which states that all elements of the game need to be thematically consistent with each other [14]. Game developers highlighted this as an aspect that helps to create a juicy game. Additionally, concepts defined in the framework such as Gameplay and Feedback coherence are also present in literature discussing game design [39, 84]. This overlap of existing understood game design practices and juiciness is interesting and points towards the fact that designers use the term juiciness as shorthand for including elements that are generally accepted as good game design. With this knowledge it is possible that juiciness could be seen as a way to make your game follow industry practices. The popularity of the term is perhaps being driven by designers wishing to ensure there game contains the same affordances for the player to increase the player's enjoyment [112].

All of the studies presented in this thesis have implemented and explored these different juicy elements to evaluate how they affected different aspects of PX, confirming what developers said in that all of these elements increased the PX through contributing to a more complete experience. While the work presented in this thesis has explored the audiovisual elements of juiciness, there could potentially be other elements that were not captured throughout the studies. It is worth considering what other elements might also contribute to a game being perceived as juicy, such as haptic feedback. Perhaps haptic feedback was not noted by designers or players due to the fact that typically haptic feedback is abstracted away from the display,

and due to the nature of haptic feedback it might be just not be present in a players recollection of gameplay. Building on these findings, we can conclude that the results point towards the concept that juiciness being the combination of many small elements that work together to create a comprehensive experience.

8.2 How does Juiciness contribute to player experience, and are its effects different from alternative approaches to engage users?

The results presented throughout this thesis have provided substantial empirical evidence that VEs and juiciness have the ability to improve PX in a number of ways.

The core expectation of this research question was framed around intrinsic motivation as defined by SDT, from the results it is clear that juiciness contributes to the PX through improving the different dimension of intrinsic motivation. Juiciness can affect a player's perceived competence through the feedback enforcing the players actions both negatively and positively allowing the player to be more sure of their in-game performance. Furthermore, juiciness is also able to affect the player's perceived autonomy through making the player's own actions feel more rewarding. Lastly, juiciness was also found to increase player perceived relatedness through juicy elements helping to make players feel connected to the task at hand. As previously discussed though there is a nuance to these findings in that throughout the studies different juicy elements affected different aspects of intrinsic motivation.

The results from the studies show that regardless of how the juiciness was implemented or the genre of the game, the inclusion of juicy elements increased the players perceived visual beauty and value of the experience. Players seem to perceive these extra elements as an indicator of the quality of the game. This echoes previous research by Hassenzahl on how beautiful things are more pleasurable to interact with [58]. This concept of pre-judging an interaction by its appearances could possibly be one of the motivations behind juiciness being so prevalent in commercial games: if

the goal is to sell a product then values that add to the perceived visual attractiveness of a game are likely to be weighted higher by those developers. Juiciness can be seen as an indicator of quality: when an interaction is juicy, the experience is positive and coherent. It would seem that players are quick to perceive these elements and attribute it to the value of the interaction.

Through this increased sense of visual appeal and satisfaction that juiciness provides, when surveying game designers a recurring concept was that juiciness helps to create a polished game where it is clear that developers have paid attention to the detail. This concept can be seen in other media where that attention to detail helps to communicate the sophistication. For example there is a clear focus on quality and attention to detail in the animation of a Disney film which helps to make the experience feel alive. These little details that help sell a fictional world in a movie are similar to the little juicy elements that help to make that game world feel alive and a joy to interact in.

Juiciness has no interaction with player performance across all of the studies presented. Player's perception of how they performed changed in the juicy conditions, the player metrics that were recorded revealed that the inclusion juicy elements does not change how a player performs in the game. Although, while there was no player performance difference the results of the first studies from Chapter 6 revealed there was a difference in player behaviour in the juicy condition, highlighting that again the context and design intent of juicy elements can change the measured effect. In this study the juicy effects were added on-top of an existing research tool following the juicy framework laid out in Chapter 3. The feedback added visual and audio rewards for performing the task correctly, but due to the nature of the gaze based task, participants would repeatedly try to get the feedback elements as they had no other way of knowing how they were doing. Throughout all of the studies presented in this thesis it is clear that even with a clear definition of juiciness, depending on the context that juiciness is implemented and the intent behind the design of said elements, it can have different subtle effects on player experience.

An interesting aspect that emerged across the results is that juiciness does not have

an impact on player performance. Existing literature on juiciness frequently points to how the increased amount of feedback should help to increase a players competence at the game [133, 77], receiving large amounts of positive feedback when completing a game task successfully. However, the results presented in this thesis show that regardless of the nature of the juiciness, it never translated into improved player skill. It needs to be noted that this lack of detecting a difference in skill could be due to the short nature of the play sessions with a player spending a relatively small amount of time playing the study games. Previous research has shown that time spent playing a game is a key factor in improving skill [37], and thus while the results show no change to player performance from juicy effects there could be an effect that only emerges after a longer period of study, which is an interesting avenue for future work.

The study presented in chapter 6 revealed juiciness in a research tool setting has the potential to improve all dimension of psychological needs satisfaction. While other methods such as gamification have been found to also work as a tool for improving these needs, juiciness allows for a different approach that much like gamification seeks to level the motivational pull of commercial games. Juiciness as a tool presents a way to increase the intrinsic motivators of games without changing game mechanics or adding new mechanics.

Existing gamification methods rely on the inclusion of new aspects that the player has to learn, e.g., individual achievements or social comparison; these can change how the player approaches and engages with the game, while juiciness sits above this on a purely aesthetic level. The inclusion of juiciness should not place additional burden on the player requiring no new learning of systems or mechanics. Although this does not mean that juiciness is an easier or better tool, instead the findings presented in this thesis highlight that its design needs to be done with care: adding more particle effects to an in-game event is not enough and can risk making the experience worse for the player.

Chapter 5 explored juiciness outside the lab setting, investigating the potential of juiciness to affect first time player experiences as measured through engagement

mechanics. Although the study revealed no significant effect, there are several interesting aspects to discuss. One potential explanation for these differences is the expectations of a game experience in a lab study vs. in-the-wild. Purpose-made games for research are typically designed for short play sessions and lack many of the features and reward structures that are present in commercial games that have also been found to increase intrinsic motivation [152]. The lab studies in Chapter 4 revealed that juiciness in the commercial game Quake III affected player motivational needs to a slightly larger extent in addition to affecting players perceived competence, which was not affected in the purpose-built research games. A lab study has a captive audience that are requested to play the game without the distractions and motivational pull of other activities; whereas in this type of in-the-wild deployment researchers are relying on participants being entirely intrinsically motivated to play the game and since it is competing with other fully fleshed out experiences. The in-the-wild study found very little impact in terms of finding an effect of juiciness on engagement.

While juiciness showed no effect on engagement in this context, due to the low sample size and the fact that the previous studies found a difference in more controlled settings there is still a potential that juiciness can affect the players first-time experience. However, there is a need for researchers to either create more robust game experiences (just adding juiciness is not enough) or to leverage existing commercial games. This chapter previously discussed how juiciness functions as designer shorthand for including many of the aspects that go into making a well-designed game, but it is clear from the studies in this thesis that it is not as clean cut: if designers or researchers add all these juicy elements, players will have a positive experience; this helps to explain the difference in results when looking at commercial games and research games deployed in-the-wild.

From these results, it would also appear that juiciness impacts aspects that affect the usability of a game, players perceived their own competence and efficiency using the system to be higher when juiciness was added. Previous research has explored the different ways to increase the usability of games [132], which interestingly often mention the inclusion of juicy elements. For example Desurvire and Wiberg's PLAY

heuristics contain rules that align with the juicy framework [29]. This does not mean that making a game juicy would automatically make it more usable, but instead suggests that the inclusion of juicy elements can contribute to the usability through emphasising aspects that are already usable.

8.3 Juiciness Impact on Disciplinary Perspectives

This thesis provides an exploration of juiciness from the perspective of Human-Computer Interaction research. It takes an empirical angle that addresses the phenomenon through interviews, surveys and empirical studies including self-reported questionnaires and player metrics as a way to understand and define, but also measure the effects of juiciness on player experience. Now that we know that juiciness can impact the player experience in a variety of manners, we should consider how other research approaches and paradigms that might be able to analyze and measure juiciness. For example, juiciness could be explored through theoretical and designerly exploration rather than predominantly experimental research. Likewise, experimental work does not need to be limited to the measures employed here; measuring participants' physiological responses similar to approaches previously used to investigate how players process visual information in fast paced games [63]. Thereby, we can study how juiciness is perceived by players at a physical level to gain an increased understanding. A theoretical approach could also provide further or potentially conflicting evidence on the effects of juiciness on the player experience, paving the way for novel insights that can only be found through studying the complete experience rather than specific aspects like intrinsic motivation as this thesis has.

Chapter 3 explored game designers' perspectives on juiciness, but this is just one discipline in the games industry. Here, it would be interesting to ask questions such as do game audio designers have the same implicit knowledge of juiciness, do they share the same usage or does another term fill that space? Likewise, level design could contribute, and visual artists would likely be able to contribute more nuanced perspectives on visual embellishments, too.

8.4 The Potential Use of Juiciness

The findings from this thesis have laid the groundwork for future work to investigate juiciness from a myriad of different angles. While this thesis has explored juiciness from a game design focused perspective it is worth considering how other disciplines may perceive their own concept of juiciness. For example, other creative disciplines such as linear media have their own tacit knowledge around experience design. An example of this is sensory marketing [157], which uses similar language to Swinks sensations around game feel [142], and usage of marketing tropes [148] which are not too dissimilar from the tacit knowledge of juicy design. With this in mind, it may be worth exploring the application of juiciness to other disciplines both to investigate if it is a useful term for describing intangible aspects but also to see if the term can be expanded on and specialised in different contexts.

While the findings presented here revealed that game designers have a tacit understanding of juiciness and its applications, one thing that did not appear in the results was the concern of making a game too juicy through providing an overwhelming amount of feedback. This could be because game designers have learned through their practice how much visual and audio information at one time is manageable for the player, and instinctively know how to avoid it. However, the concept of too much juiciness has manifested in games media and forums, typically with a focus on players disliking certain aspects of juiciness. For example, the game *Rocket League* features heavy screenshake for important game moments like scoring a goal but is frequently turned off by expert players as they report it to be distracting and have an impact in their control of the game [115]. There is the potential for conflict between the designer trying to create as positive gameplay experience as possible through juicy elements, but that some players will wish to turn off some aspects such as screenshake. None of the findings point towards the inclusion of juiciness being considered overwhelming by participants, the methods we used would not necessarily pick up on participants feeling overwhelmed by information, which therefore warrants additional research exploring the concept of too much juiciness. Lastly, it is worth considering the accessibility angle of juiciness. While it is frequently used to

convey the state of the game, there are clearly instances where players wish to turn off these elements because they are actively harming the accessibility of the game. An important research question is how designers can ensure that the game is providing enough game state information, while also allowing for players to customise the visual and audio feedback to their own needs.

We found that juiciness can affect how competent a player feels at the game, and this effect persisted across all games we studied. In all of these games, the amount of juiciness was consistent throughout the experience e.g. the particle effects for defeating an enemy in *Dungeon Descent* were the same throughout the experience. .Games typically included a tutorial or highly structured introductions to ensure that players grasp the mechanics of the game, frequently requiring players to evidence competency before being allowed to progress. In this context, the amount of juicy elements could be designed to vary based on how the player is progressing with respect to learning the game mechanics. This is quite similar to the learning principle of scaffolding, where the learning materials are tailored to the needs of the student [8]. Scaffolding is also used as an approach by designers, typically in the process of level designer and teaching players mechanics [54], but it could also be studied further with juiciness. A game experience could feature more explicit successive feedback to help the player initially learn the rules of the game and then ease off to stop it from becoming redundant. The novelty of juiciness might also play into this issue, and is worth further exploration. The findings in this dissertation were produced using short gameplay experiences, hence the question remains how results might change over a longer period of play where players are exposed to the same juicy effects repeatedly. Would players' perceived competence be lower after seeing the same rewarding feedback? Swink's game feel sensations discuss the idea of appealing reactions needing to be novel through variation, which we can see applied in commercial games [142]. For example, in many FPS games, the sound of firing a gun varies in pitch, bass, and shape for each repeated fire to avoid the playing becoming bored of the sound, and a similar approach could be applied to juicy effects where suitable.

This work has looked at juiciness as it is currently understood in modern game

development. It would seem that the advancement of game engines and hardware can impact how juiciness is constructed, while games from the past can be considered juicy e.g. *Tetris* , it potentially is applied differently. More powerful hardware has lead to increased graphical fidelity which has potentially changed how developers view and apply uicy feedback for e.g. comparing *Tetris* released in 1987 to *Tetris Effect* released in 2018, both games have the same core mechanics but *Tetris Effect* is filled with graphically rich visuals and sounds. We would expect that the way that juciness has been applied has changed over time, the juicy framework could be applied to analyse older games to see how they might differ compared to modern games. This could open up new angles for determining the impact of graphical fidelity of juiciness for example, which comes naturally with technical advancement.

8.5 Beyond Juiciness in Games

So far this chapter has discussed juiciness exclusively in the context of games, but the results provide an interesting motivation for exploring the use of juiciness as a tool for improving any interactive system. Discussed here is a rationale for why juiciness is relevant beyond games, and a conceptualisation for what that might look like using the findings of this thesis.

A consistent finding throughout this research was that juiciness increased the visual appeal of the games while also increasing the perceived quality of the interaction (increased PX). This follows the school of thought of some academics in that beautiful things work better [103, 104]. Within the context of the results it is clear that there is some overlap between juicy design and Norman's three layers of interaction aesthetics. The visceral layer detailed the quick judgements that inform the quality of the interaction and as Norman states are genetically determined but evolve over time. Aspects such as symmetry, warmth, or smooth objects are judged on this visceral layer [105]. When looking at the results in the context of this layer, juiciness appears to appeal to this lower layer of interaction through the sensuous feedback it provides, making every action appeal to this visceral layer of interaction. The behavioural layer

deals with the interaction experience as it happens, is the interaction pleasurable in its nature? Does the user feel effective? [104] The results from this thesis would point towards juiciness appealing to this layer of interaction, with players perceiving increased competence at game tasks and rating the juicy versions more pleasurable and preferred. Lastly is the layer of reflective emotion, the feeling of satisfaction of the interaction, again the results show that juiciness can appeal to this emotion through it's feedback elements. The results from this thesis can be used to help inform and guide of these juicy elements outside the context of games.

It has been found that a person's emotional state and reactions have an effect on their ability to make decisions [72]: people are more creative when they are interacting with attractive things because they feel good to use [104]. Because of this creative emotional state users are more creative in coming up with solutions to problems they encounter in interactions [4]. Based on the findings of this thesis, it would seem that juiciness can serve as a way of making non-gaming interactions more attractive, providing in conjunction with the framework presented an actionable way of adding visual attractiveness and appealing to Norman's layers of interaction. Any interactive software could make use of these findings and while the studies in this thesis looked exclusively at games, aspects of juiciness can already been seen in day-to-day interactions; for example, deleting an application on an iPhone, involves all of the applications shaking to indicate they can be deleted bestowing a sense of anthropomorphic quality to the applications as they shake with fear. Another example is the original Xbox 360 dashboard navigating between the different panels of the user interface provides the user with visceral audio and visual feedback that make it a satisfying to simply scroll between the different panels, with users reflecting on how satisfying it was to use [40].

While this section proposes that juiciness could be leveraged outside the context of games as a way to make more enjoyable interactions or experiences, this would not be the first time that academics have leveraged the motivational pull of games. Gamification has been widely used by the research community [135] and industry as a way of increasing user motivation to engage with a system. As the results show juiciness can increase all the factors that govern intrinsic motivation, juiciness has

the ability to function similar to gamification in that it can be leveraged outside the context of games to harness the intrinsic motivational pull of games, for example, using juicy feedback elements to draw the attention of users of self-driving cars, helping to communicate and highlight state of the world change.

While these findings address the research questions outlined in the first chapter of this thesis, the results also raise many new questions and provide opportunities for additional research. A number of avenues and challenges surrounding juiciness in future work remain.

Chapter 9

Conclusions and Future Work

This thesis investigated the game design concept of juiciness through exploring previous literature and engaging with game designers to explore their understanding of the concept, which fed into the creation of an empirically grounded definition of juiciness. On the basis of this definition, this thesis has also presented several user studies that have explored juiciness in a variety of contexts, demonstrating that juiciness can affect the PX through positively affecting factors related to intrinsic motivation and the visual appeal. This thesis revealed that juiciness functions as a designer shorthand for making a complete experience and provided an actionable framework to be used by researchers and practitioners for applying juiciness to experiences. This thesis has detailed how adding juiciness to a game can increase the intrinsic motivation of players through enhancing aspects such as competence. Although, the results show that the implementation and design of juicy elements need to be created with care and consideration for what aspects of the experience are being targeted. Additionally, this thesis has shown that juiciness affects the visual appeal of games for players but has no effect on player performance. These findings do raise additional questions such as proposing a deeper look at the audio and haptic feedback elements, or investigating the suitability for juiciness outside the context of gaming.

This chapter discusses three main areas for future work: isolating the effects of other potential providers of juiciness, mainly audio and haptic elements, isolating individual juicy elements to create a taxonomy to be leveraged by researchers and designers, and plans to further explore juiciness beyond the gaming context.

9.1 Modality of Juiciness

This section explores the potential for future work to go beyond the visual aspects of juiciness in games.

9.1.1 Audio

While the work in this thesis has explored and investigated the visual aspect of juiciness and briefly touched on the audio aspects, further work should build on these findings through looking in a more in depth manner at the different audio elements that are present in games such as music, ambient audio, and sound effects. The results of chapter 6 revealed that the audio elements that were added (sound effects and dynamic background music) in conjunction with visual elements contributed towards changing player behaviour. Future work here can explore the potential for these audio effects to improve the PX but also to study the potential of influencing player behaviour, as this was something that was not observed in any of the other studies in this thesis, which could be due to them only containing juiciness through visual elements.

There is a motivation to explore the effects of dynamic background music in more depth. Rogers et al. found that the design of a games background music can have an effect on the player behaviour [122]; future work could explore if this effect manifests itself differently with juicy background music. Additionally, previous work has found that audio elements increase the player's perceived presence [123]. This could be built upon to explore what elements of the PX do juicy sound effects contribute. While previously this thesis has discussed that juiciness is a complete whole where all the small elements come together, it would still be useful for researchers to better understand the impact of individual elements that are easily split out to allow for the possibility to add juiciness to target a particular aspect of the PX.

9.1.2 Haptic

When playing a game there is almost always a physical input through an input device that has a one-to-one response to interaction. As the juicy framework from chapter 3 showed, a player pressing a button should yield a direct confirmatory piece of feedback. However, what needs to be explored is how the nature of the juicy haptic feedback can affect the PX. Previous research has tied haptic feedback to be an important contributor to a players sense of presence [143]. If feedback to a physical action is responded with a physical feedback element, for example through vibrating the input device, how does the player perceive this, does it have an effect on the intrinsic motivation aspects? It would also be interesting to see if juicy haptic feedback can affect how a player perceives the value and beauty of a game in line with other aspects of juiciness. Another line of enquiry in relation to haptic feedback could also be exploring the design of haptic feedback: what does superfluous and sensuous haptic feedback look like when the feedback channel is typically limited? Practitioners have begun to explore the depth of haptic feedback: for example with the Nintendo Switch, the Joy-Con controllers come with a more complex vibration system consisting of several motors that allow for different types of force feedback. A notable example of a game using this is *1-2-Switch* which makes use of the rumble to guess how many objects are in a box through only haptic feedback. Future work should aim to establish an in-depth understanding on how haptic feedback affects the PX and consider how juicy haptic feedback could be manifested.

9.2 Towards a Comprehensive Understanding of Juiciness

The work throughout this thesis has laid the foundation of our understanding of juiciness but there is still a significant amount of future work that needs to be done in order to have a fully comprehensive understanding of juiciness and its many facets.

A limitation of all of the studies presented is that they focus on specific genres of

games, hence studying a broader range of game genres (e.g., real-time strategy, or sports games), would allow for a greater understanding of how juiciness can affect the PX and visual appeal of games. Are their game genres in which the effects of juiciness are more pronounced or absent? One potential avenue could be recreating the same study structure as seen in chapter 4 but with other popular genres. Extending on this it would be worthwhile to study the impact of level of complexity (i.e., casual games and other games with a limited number of core mechanics versus more complex approaches such as sandbox-style games).

The significant results of this thesis were measured in lab study settings. Future work should also continue to explore these effects in a real-world setting similar to chapter 5, using in-the-wild deployment of games to evaluate if the findings still hold true in a real world setting. As adding juiciness to games helps to foster intrinsic motivation, future work could also consider exploring the potential of juiciness's long-term impact on engagement both in an industry setting and for serious games such as training tools that require long term engagement to see effects. In this space juiciness might be a way to increase participants motivation to play.

The studies did not explore how the fidelity of juiciness elements influenced PX, and this could be an interesting direction for future work to explore as previous work has found that graphic fidelity can affect the PX [50]. The levels of fidelity that are present in a juicy element could have an effect on how the game is experienced. The games industry is currently placing quite a large focus on remastering games to increased their fidelity; it would be interesting to leverage this industry change to explore this issue further. Additionally, an off-shoot of this work could study juiciness in relationship with graphical realism (e.g., its impact in abstract versus photo realistic game worlds).

In a more general sense, future work should also seek to study the impact of separate elements (e.g., screen shake compared to a particle effect) to gain further insights into the effects that juicy design may have and to begin the long term work of building a taxonomy of juicy elements with an understanding of how each element contributes to the PX that would be useful for game designers and researchers for improving aspects

of their games. While the framework for juiciness that is presented in this thesis has provided a way to analyse juiciness for both practitioners and researchers in existing games, one area that is still unaddressed is how to implement juiciness. While the framework is able to point out areas that are lacking in an experience, the next step of improving the framework will be to explore how juiciness can be implemented, offering actionable recommendations for researchers and designers wishing to leverage juiciness in their work.

9.3 Applying Juiciness Beyond Games

While the studies and results throughout this thesis have focused on the effects of juiciness on PX in a gaming context, there is a strong motivation for exploring the potential for juiciness to be used outside this gaming context and applied to more general interaction design or potentially non-interactive mediums.

Gamification has been widely used as a method for extracting aspects of games that are motivating and applying them to non-gaming contexts to varying success [135]. The original definition of gamification by Deterding et al. considered any application of a game element in a non-gaming context. Juiciness fits into this, but likely due to the loosely defined nature it did not see widespread use [33]. The results have shown that juiciness also affects intrinsic motivation aspects. Future work should explore if the motivational pull of juiciness can also successfully be applied to tasks to help with engagement in the same way that gamification is currently being used [108].

There is also space to explore the potential of juiciness to make tasks more pleasurable, through the concept of beautiful things working better [58]. Future work could investigate whether elements of juiciness already exist in interaction design: aspects of juicy elements can be discovered in many everyday interaction experiences. For example, the 'like' button on Facebook Messenger includes an effect that could be considered juicy (it shakes and grows in size the longer you hold the button down), possibly making it a rewarding experience and allowing it to potentially convey more meaning through being engaging to use.

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Appendix

9.4 Appendix Item 1

This is a web capture of the online survey created to investigate developer perspectives on game feel presented in Chapter 3.

Game Feel Questionnaire

Hello, thank you for taking the time to fill out this short survey. The purpose of this study is to gain insight into both player's and game designer's perspectives on the topic game feel and juiciness.

The data obtained may be published for academic purposes but will remain anonymous.

All the data recorded is completely anonymous and you are free to opt out of it being stored on request. If you have any further questions or wish to opt out please email me at khicks@lincoln.ac.uk

Please select your gender

Select a gender

Please Choose.

What is your age?

Age

Have you ever worked in a game design related role?

- Yes
- No

Game Feel Questions

The following questions are surrounding your perspective on game feel. Game feel in the context of this questionnaire refers to how the game feels to play

Please explain what the term "game feel" means to you?

What mechanics or game aspects do you feel lead to positive game feel?

Please name a game that feels great to play?

What aspects foster it feeling great?

Please name a game that doesn't feel great to play?

What aspects lead to it not feeling great?

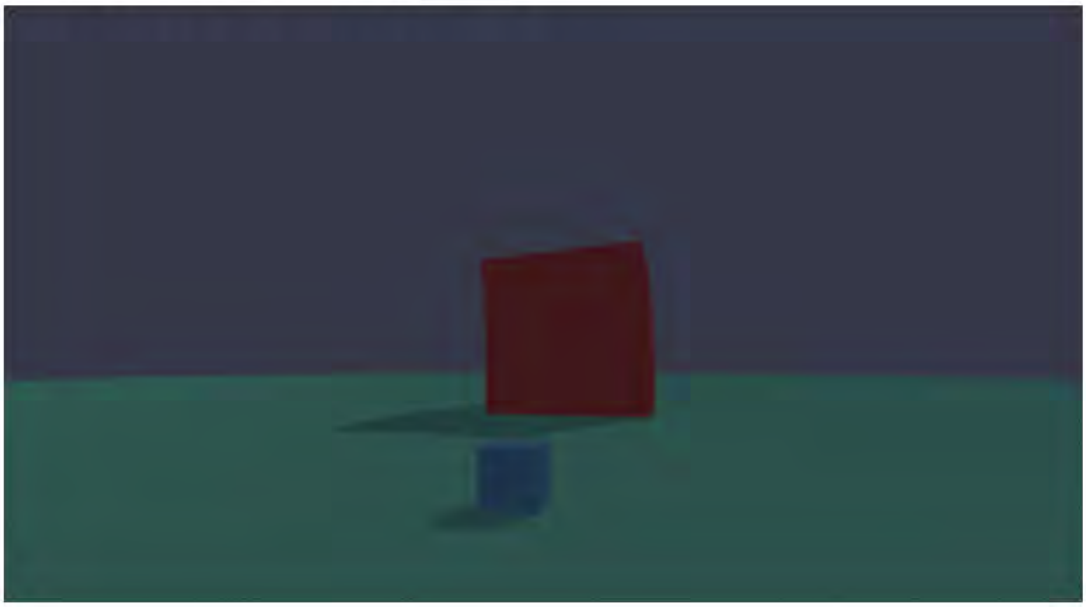
Please name a game that you felt rewarding to play?

What aspects lead to it feeling rewarding?

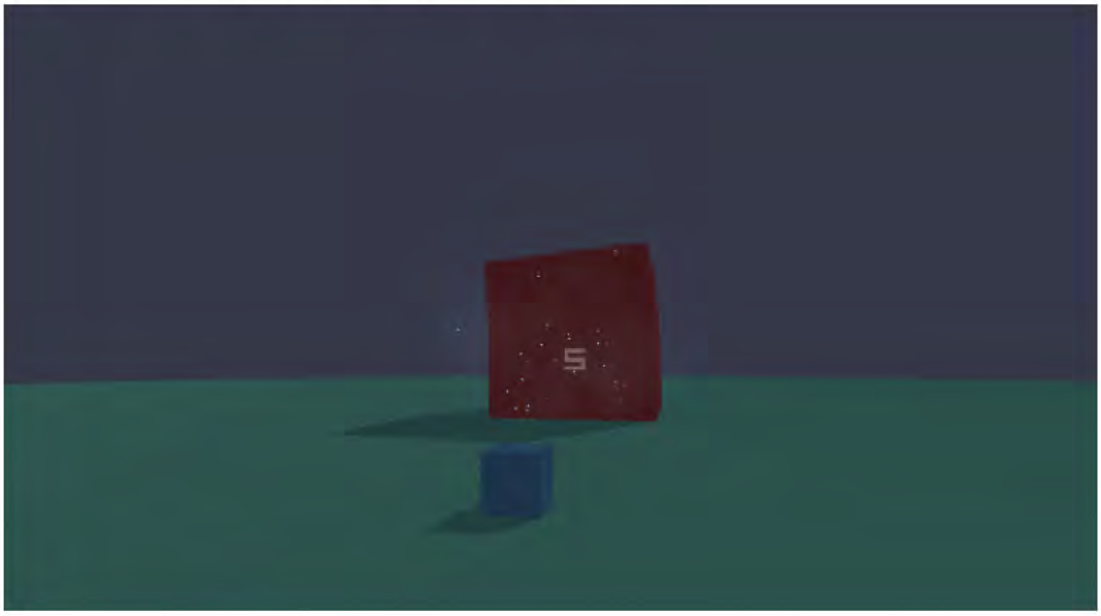
Juiciness

This section contains questions that surround the concept of game juiciness, more specifically what elements you consider to be juicy. Juiciness refers to appealing feedback both visually and audibly that responds to player actions, where a small amount of input can yield a large amount of feedback. A game with lots of juicy feedback will be satisfying to interact with. Below are several GIFs that visualise several juicy elements.

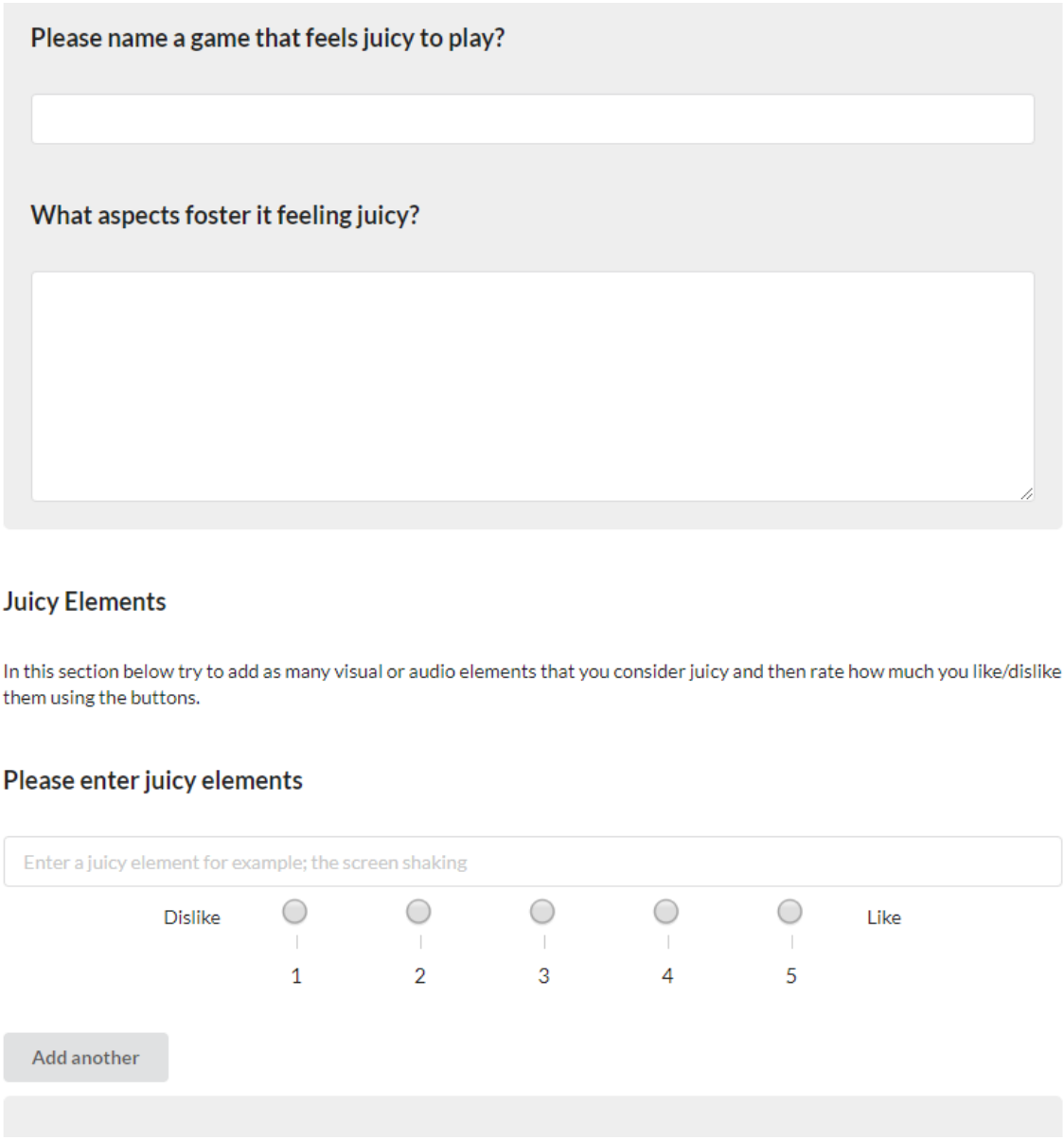
Below is a gif of a game with no juicy elements



The game below now has several juicy elements applied



What effect if any, do you feel these juicy elements have on the player?


Please name a game that feels juicy to play?
What aspects foster it feeling juicy?
Juicy Elements
In this section below try to add as many visual or audio elements that you consider juicy and then rate how much you like/dislike them using the buttons.
Please enter juicy elements
Enter a juicy element for example; the screen shaking
Dislike
Like
1
2
3
4
5
Add another

Anything else you would like to mention in regards to game feel and juiciness?

Email Address

In addition to this questionnaire some participants will be invited to take part in a brief interview. If you would be happy to do this please fill out your email address below so we may contact you, this will not be shared with anyone.

Confirmation

By submitting this questionnaire I consent for the provided data to be analysed as part of a study into game feel and juiciness in games. I understand that the data will be kept anonymous and I can contact the researcher khicks@lincoln.ac.uk if I have any questions.

Submit answers