Master Degree Project

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JUICE VALIDATION

The Player Experience

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Abstract

Juiciness does not have a widespread understanding in both the games industry and academia. By using several sources from the industry and formal research on game feel, juiciness, and cognitive theory, the function of juiciness was found to be a multimodal learning tool which focuses on feedback, clarity and coherency within a game. The design of juiciness involves the tasks of Game Characteristics Alignment, Game State Integration, and Direct Feedback Design. By using several sources as a foundation, a definition was created that can be better used in a broad development context which aims to reduce confusion on what juiciness is so it can be better communicated between disciplines. In order to validate that juiciness is serving its function, the player experience and presence was measured via a mix of standardized questions from known questionnaires together with specific questions for the juiciness and game. The impact of the juiciness on the experience was clear and problematic areas was identified. This results in an iterative process which becomes part of the game development process.

Keywords: Games, Juice, Juiciness, User Experience (UX), Cognitive Theory, Quality Assurance (QA), Polish, Questionnaire, Playtest, In-The-Wild

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1 Introduction

Juice is primarily a game design term used by developers in the industry and is still not a term which is widely understood or has an agreed upon definition which is widely used. Here a combination of game feel and juiciness research has been put into context of each other to draw out what juiciness is and its goal. The definition derived from these sources was "Juiciness is the polished feedback, clarity, and coherency of game elements that aim to improve the game feel and create a sense of flow to heighten the player experience". The main works used were the juiciness framework by Hicks et al. (2018) and the design domains of Pichlmair and Johansen (2022). Hicks et al. (2020), Pichlmair and Johansen (2022) and the work of other researchers on game feel design have been put together to refine the design process of juiciness. This process was tested in an industry project through the game studio Northrak, with their pre-alpha game *Close to Flight*, to try and answer what makes a good validation process for juiciness and specifically what should be in a playtesting questionnaire for that purpose. The effectiveness of the implemented juiciness was measured as players' experience using an exploratory approach. This approach was first tested in a pilot study to evaluate what kind of questionnaire is best suited for this task. The resulting questionnaire was then used to validate the juiciness designed for *Close to Flight*. The goal of this approach is to include as many variables as possible of what juice encompasses. There is a lot of research about multimodal information and how it interacts with the human cognitive architecture with varying claims. In the case of juiciness, claims are that it does not affect actual objective performance, only perceived player performance. Meanwhile newer research suggests that multimodal information supports learning if it is done the right way. Thus, the questionnaires are focused on the player experience and their understanding of the implemented juiciness. The aim is to answer what is a good validation method in a real development environment. This is a different goal than most academically standardized questionnaires as they focus on measuring the experience rather than identifying problem areas to inform design decisions.

2 Background

2.1 Designing for Player Experience

The player experience is often at the core of games. It is what informs the design of the game as a whole. This is exactly what Fullerton's playcentric design process is all about: "keeping the player experience in mind…" during the design process from the conception of the idea through the entire development process (Fullerton, 2019, p.12). This approach also places a heavy emphasis on playtesting which is used as a tool to evaluate the direction of the project. This is crucial to make corrections to achieve the intended experience or to iterate on the experience to improve it. It is so essential to the design process that "People in the industry are realizing that this lack of player feedback means that many games don't reach their full potential" (Fullerton, 2019, 12). It is then recommended to start out the game with a deep understanding of the clearly defined experience goals, because these are the basis of the game itself. This deep understanding together with the game's mechanics is key to understanding the goal of each playtest. Without a clear playtesting goal, it will be difficult to produce any meaningful actionables from the end results. Without any resulting actionables from playtesting there will be no further improvements to the game.

2.2 Designing for Feel

One of the core parts of the player experience is game feel, which is a fairly broad aspect of games that designers tailor to create a specific experience. Martin Pichlmair and Mads Johansen (2022) defines the design of game feel as "Game feel design is the intentional design of the affective impact of moment-to-moment interaction with games" (Pichlmair and Johansen, 2022, p.138). As moment-to-moment interactions involve several elements of a game there are a lot of tools designers can use to achieve their desired feel. According to Steve Swink the experiences that create great feeling games are:

"- the aesthetic sensation of control
- the pleasure of learning, practicing, and mastering a skill
- extension of the senses
- extension of identity
- interaction with a unique physical reality within the game"

(Swink, 2017, p.10).

Though Pichlmair and Johansen (2022) explains that the definitions Swink (2017) are using are limiting as they do not include all games to have the quality of game feel (Pichlmair and Johansen, 2022), arguing that Swink excludes games with real-time controls. They also state that "narrative content, music, art, and many other aspects of a game influence how it feels" (Pichlmair and Johansen, 2022, p.138) in addition to the focus of their article: visual and haptic feedback. With game feel being this wide in what it encompasses there are several terms out there which describe different types of experiences of game feel.

One such term is friction. It can be viewed as an alternative term for how a game feels and can be defined as "Friction is the experience of the player pushing against the boundaries of the system" (Pichlmair and Johansen, 2022, p.138). This does not mean that friction is inherently a negative experience. Rather in the context of games friction is akin to physical friction where the context of the desired friction, and how it makes the player feel is what makes it bad or good. Friction here could be used to describe difficulty of use; pushing against what the systems intended difficulty is. Good friction could be the intended difficulty of controlling the player avatar, and bad friction could be difficulty of interacting with the game UI. This illustrates how "Friction is often experienced by the player over a longer duration than moment-to-moment interaction, as it extends over several game elements. Friction can be the defining element of a game" (Pichlmair and Johansen, 2022, p.138).

The usefulness of friction becomes apparent once flow is brought into the context of game feel. Designers do not want to create bad friction in areas of the game where friction is expected to be low, as in the UI example. Players might expect to get into the game from the main menu easily and not be met with layers upon layers of menus. Through these examples we can observe that good friction can create challenges, while bad friction can create artificial challenges. The first which empowers the player, while the other annoys and disrupts. Pichlmair and Johansen (2022) say that game feel is mainly linked to three of the several criteria of flow: that concentration is possible because the task has clear goals, that concentration is possible because the task provides immediate feedback, and the ability to exercise a sense of control over actions (Pichlmair and Johansen, 2022). These three points are present in their game feel domains table where they showcase what their respective polishing tasks are and additionally aid designers to talk about game feel in a more precise manner. Tuning the simulation to clarify goals, juicing the immediate feedback for clarity, and streamlining inputs for a sense of control over actions.

Design Domain	***Physicality***	***Amplification***	***Support***
Domain Description	The physical simulation	Intensification of experience	Enabling the player
Polishing Task	*Tuning*	*Juicing*	*Streamlining*
Task Description	Setting parameters to specify the behavior of objects	Adding feedback to emphasize, clarify, and amplify	Acting on the player intent by interpreting the input in context of the gameplay situation

Table 1: Game Feel Domains and Their Associated Polishing Tasks (Pichlmair and Johansen, 2022)

2.3 Designing for Juice

Pichlmair and Johansen (2022) describes the domain where juice comes from as amplification. They say that "The goal of juice is to make actions feel significant and the results can be measured" (Pichlmair and Johansen, 2022, p.139). Through the game feel domains table (Table 1) we know that what they define "feeling significant" as creating an emphasis on something, clarifying and, or amplifying it.

Hicks et al. (2018) on the other hand created a game juiciness framework where they say the three important parts of juiciness are: Game Characteristics, Game State, and Direct Feedback (Table 2). These three sections of the framework were the only remaining themes after a refinement process on the observed themes from a survey on how game developers understand juiciness (Hicks et al., 2018) (Table 2). The two sections that were entirely removed were slickness, and dimensions of experience. The reasoning for their removal was they were either too vague or too broad. As slickness was not easily applicable because the questions it contained did not reveal anything about juiciness and suffering from being too high level. Meanwhile dimensions of experience fit other game aspects, likely more fitting elsewhere within game feel. As they identified highly relevant items Hicks et al. says that: "how the game state is conveyed to the player, questions on the exaggeration of elements, and focus of attention" (Hicks et al., 2018, p.12) where key in highlighting important elements in *Candy Crush Saga* (2012). They also observed that complimentary mechanics and systems contribute to the juiciness, and lastly how the direct feedback questions aided in observing the differing feedback elements. The remaining questions were then further tested through analysis of *Downwell* (2015) were they ended up more refined or removed by being non-actionable. The final framework can be seen in Table 2.

Hicks et al (2020), Pichlmair and Johansen (2022) mention that there is a point were adding more juiciness no longer has a benefit and can instead be counterproductive. This is a topic which they demonstrate has been studied by several people in their paper (Pichlmair and Johansen, 2022). We see the same in The Game Juiciness framework suggested by Hicks et al. (2018) through a big focus on coherence and clarity which are the keys to avoid over juicing the game. Keeping clarity in mind with the players' focus of attention and what elements are highlighted restricts the ability from adding too much during design tasks. This is because it prohibits the designer from creating distractions from what is important in the game, where too much multimodal feedback becomes overwhelming to where other game elements are difficult to track.

This is what is referred to as cognitive overload. John Sweller (2024) discusses the implications of human cognitive architecture, how too much information in short term memory can impede learning outcomes and the differing ways this can happen (Sweller, 2024). It is more generally accepted that redundancy in information will reduce learning capabilities, but Albers et al. (2023) showcases that there is value in dividing redundancy into differing types which they define as: content redundancy and modal redundancy (Albers et al., 2023). This is not yet widely studied yet, and researchers have differing results while using differing definitions and terms, but they all agree that there are measurable benefits from informational redundancy, and it is not all reductive to learning outcomes.

> "Another question that arises is whether there is an influence on which information is presented in which format. For example, Hegarty (2014) has already shown that dynamic information can be better processed when presented via visualization. On the other hand, verbal information serves better when linear structures (e.g., sequences of events) must to be learned. These findings are also relevant for redundancy research. Imagine having the same information in both visualization and written text. In this case, the complexity of the information is moderated by the presentation format: if a visualization has low complexity while a written text is highly complex, we will likely see different redundancy effects depending on the control condition. If the visualization is the control condition, we will probably see a negative effect of redundancy because the visualization was already essential for understanding, and the addition of complex written text hampers learning. By contrast, if the written text is the control condition, we will likely see a positive effect because the learner will benefit

> from the addition of the visualization. This example shows that aspects of element interactivity must be considered. Element interactivity describes “the degree of interconnectedness between essential elements of information that should be considered in working memory at the same time”” (Trypke, 2023, p.14)

Pichlmair and Johansen (2022) says that “One could even go so far as to argue that all cognition is rooted in feedback from the real world that we actively engage with in a process of interactive cognition" (Pichlmair and Johansen, 2022, p.139). Although they do not explicitly reference any psychology, neuroscience, or cognitive load theory such as John Sweller (2024) and Fabian Albers et al. (2023) or others as a majority of this research is too recent to have been included. Even though they do not demonstrate the connection between cognitive overload and juiciness, rather they exemplify it through citing other works on juiciness and lists references to ‘How designers work - Making sense of authentic cognitive activities’ (Gedenryd, 1998), and ‘On managing moods: Evidence for the role of homeostatic cognitive strategies in affect regulation’ (Forgas and Ciarrochi, 2002). How designers work does briefly discuss Miller’s theory of the magical number seven where the theory is used to point out working memory has its limitations. However, Pichlmair et al. mentions that information on the screen such as the interface are a service to the player as this information no longer needs to be in the working memory and alleviates the strain it otherwise would cause but does not go into deeper details (Pichlmair and Johansen, 2022).

Another topic which is briefly mentioned by Pichlmair and Johansen (2022) is that not everything is serving the player, but rather the potential viewers, making it clearer or more fun to watch the gameplay (Pichlmair and Johansen, 2022). In the same vein of thinking, in Greg Street’s (2017) talk about balancing in *League of Legends* he mentions that it is not all about balancing. There are several factors which influence their design and balancing decisions, one of which are related to pro play and what makes the game fun to watch (Street, 2017). We do see this kind of trend in several competitive games where the aim is making it easy to understand what is happening without knowing the exact mechanics such as *Counter Strike 2* (2023), *Deadlock* (2024), *Valorant* (2020), *Marvel Rivals* (2024), *Smite 2* (2024), *Fortnite* (2017), *Apex Legends* (2019), and more. This is a decision which needs to be guided by the core experience and has no current empirical answers to what too much focus on is supporting viewers versus supporting the player experience. Though as Street says, there is a balancing act to find the right amount to help viewers understand the gameplay. With that said there is an argument to be made within marketing for creating feedback which entices viewers, making them interested in the game by just looking at gameplay making them more likely to buy the game. As there may be cases of where a game has good juiciness but is so complicated that watching it is difficult to understand. This is an aspect which is not directly solved here, but by pointing out this fact may help in analysing juiciness with a different perspective through clarity.

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 reactions to action 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: Does the game give a direct response to physical input of a button? **C2. Multimodal:** Is feedback for one action presented on multiple channels at once? (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 emphasize actions already communicated in other ways, or minor player actions (without overlaps with C4.A)?

Table 2: Finalised Juicy Design Framework (Hicks et al., 2018)

2.4 Domains and Framework Overlaps

The concepts discussed so far have been Player experience, flow, cognitive theory, game feel, juiciness, and what juiciness entails according to the design domains by Pichlmair and Johansen (2022) as well as the juicy design framework by Hicks et al. (2018). Most of these which build on top of each other, narrowing down what juiciness is, but then it diverges upon the design domains, and the framework which has several overlaps and differences.

Comparing the juicy design framework with the design domains we can observe that the three concepts in the design domains are partly compatible with the three sections of the juicy design framework (Table 2) by Hicks et al. (2018): Game Characteristics, Game State and Direct Feedback. Firstly, let's address game characteristics which is the part here that does not neatly fit into the juicing task in the design domains. Rather it better lines up with the physicality domain and the tuning task. Although Pichlmair and Johansen (2022) do not mention clarity in the physicality domain, which is what is resulting from these tasks. Although it is important to note that the tasks themselves are different even though they achieve similar goals. In other words: setting parameters to specify the behavior of objects is inevitably creating a coherency between game elements. Which arguably means that this falls under juiciness as Hicks et al. (2018) has suggested. As an example, say that the tuning task from the physicality domain is to tune the player's jump graph which controls its gravity over time during the jump. Tuning it in such a way that it acts in the way that the player should expect in cases where they keep holding the button or pressing it quickly, answering the first question A1: Do actions translate into feedback that is expected. Now if the player enters a different planet which modifies this gravity, we should look even closer at the tasks which are defined under the Game Characteristics section; A2: Are the world and reactions to events believable in the context of the game? A3: Are the mechanics compatible with each other? And A4: Does feedback reflect the importance of the event?

Firstly, let's look at A2. This example highlights the focus of tuning which ends up being if the tuned physicality is believable in the context, if not, do the values need to be changed or is it the theme? As for the latter, this is where the tasks separate themselves and are no longer tuning as it turns into an aligning and design task of the coherence of several other thematic elements. Though if it is not the theme that needs change, this can be solved by tuning. Though it might not be so clear if this applies to A3 and A4. Hicks et al. (2018) did not leave any guide on how these questions should be applied so one could interpret these questions as: is there an incompatibility that stems from variables that's out of tune? Though I find it unlikely this is what was intended. At the point where this kind of issue would arise would be on a higher level in the hierarchy, outside of the polishing group as this is rather a game design issue. Rather it should be used as a communication compatibility, in this context we can ask ourselves if it is intuitive to use the mechanics together. As another example: it would not be intuitive to have logic based on science in a puzzle game which then is not scientifically accurate, then the mechanics are not compatible with each other and need change. Lastly A4 could fit in with the context of tuning the values of certain feedback, such as sizes, amounts, and visibility. Like the amount of health that is restored when a player uses a health item. Tuning does not directly change feedback but through changing specific values to where visual differences become more significant, or in other words showing the significance of the event is an area where it has influence. In all, tuning could fit under game characteristics as many characteristics are pure data which can be changed, but for ones which are not just data, tuning cannot accurately describe such tasks, but alignment can. Here aligned game elements refer to when a player observes how elements are presented; they can infer how other game elements or mechanics functions. Misaligned elements would then create confusion about the consequences of certain events and actions, or implications of mechanics. In other words, it is not effectively teaching the players the correct reactions. Thus, this category will be renamed to game characteristics alignment or just characteristics alignment for short, and tuning will be left as is.

Streamlining is another polishing task in the design domains. It focuses on enabling the player. This is one of the goals of juiciness as well, though the description of the streamlining task separates it from juiciness very clearly: “Acting on the player intent by interpreting the input in context of the gameplay situation” (Pichlmair and Johansen, 2022, p.147). Neither game characteristics, direct feedback or game state is concerned about interpreting the players’ intent. We can more clearly highlight this difference by pointing out that this can only be done through mechanics. In contrast, juiciness focuses on feedback, clarity and coherency. It is meant to support the player in understanding the wholeness of the game through several modes of displaying information to enhance their interactions with the world so that they can learn the rules of the virtual environment. Though the section of the game juiciness framework which fits the description of supporting the player the most is game state and direct feedback. In game state the design goal is to support the players’ cognitive functions to focus on the right things while also giving relevant and visible feedback that does not distract from the main event and can still be easily understood. (This is exactly what Trypke explains in the quote referenced earlier). None of which changes how the players’ input impacts the game as a whole. Thus, to highlight the difference, streamlining will be renamed to mechanical streamlining and game state will be game state integration referring to the act of integrating the game state into the world as it can have differing ranges of visibility available to the player depending on how juiced the game is and what is important at certain points of gameplay.

The only parts which are now missing are the juiciness task and direct feedback. We could easily say that these are the same, although as mentioned the description of streamlining also functions for direct feedback. Which indicates that juiciness is not only found under amplification but also support. Juiciness’ task description says, “Adding feedback to emphasize, clarify, and amplify” (Pichlmair and Johansen, 2022, p.147) we can pinpoint clarification as the element which supports the player. Initially this may not seem important, but it is compatible with reward schedules. Giving the player the correct feedback when something is rewarding versus not, is key to having a good reward schedule so players can reach the intended big rewards in the first place. Direct feedback may not be a requirement for players to reach those goals, but as stated, it supports the player in getting there. As a lack for a better term for this it will be renamed to direct feedback design, or just feedback design for short.

Figure 1 showcases the discussed relationships in a hierarchy. This is to create clear differences between each element, but in practice its not that straightforward. The juiciness tasks are not mutually exclusive, they overlap each other as they have the same results to varying degrees of weighting on each feedback, clarity and coherency. Which would also be affected by each task’s scope. A venn diagram would be more accurate in highlighting the relationships of the player experience, flow, feel, polish and juiciness, but what is listed here are not the only influences on those elements which would result in an incomplete diagram. Though the main focus is on the juiciness tasks and not the overlaps of everything related to the player experience.

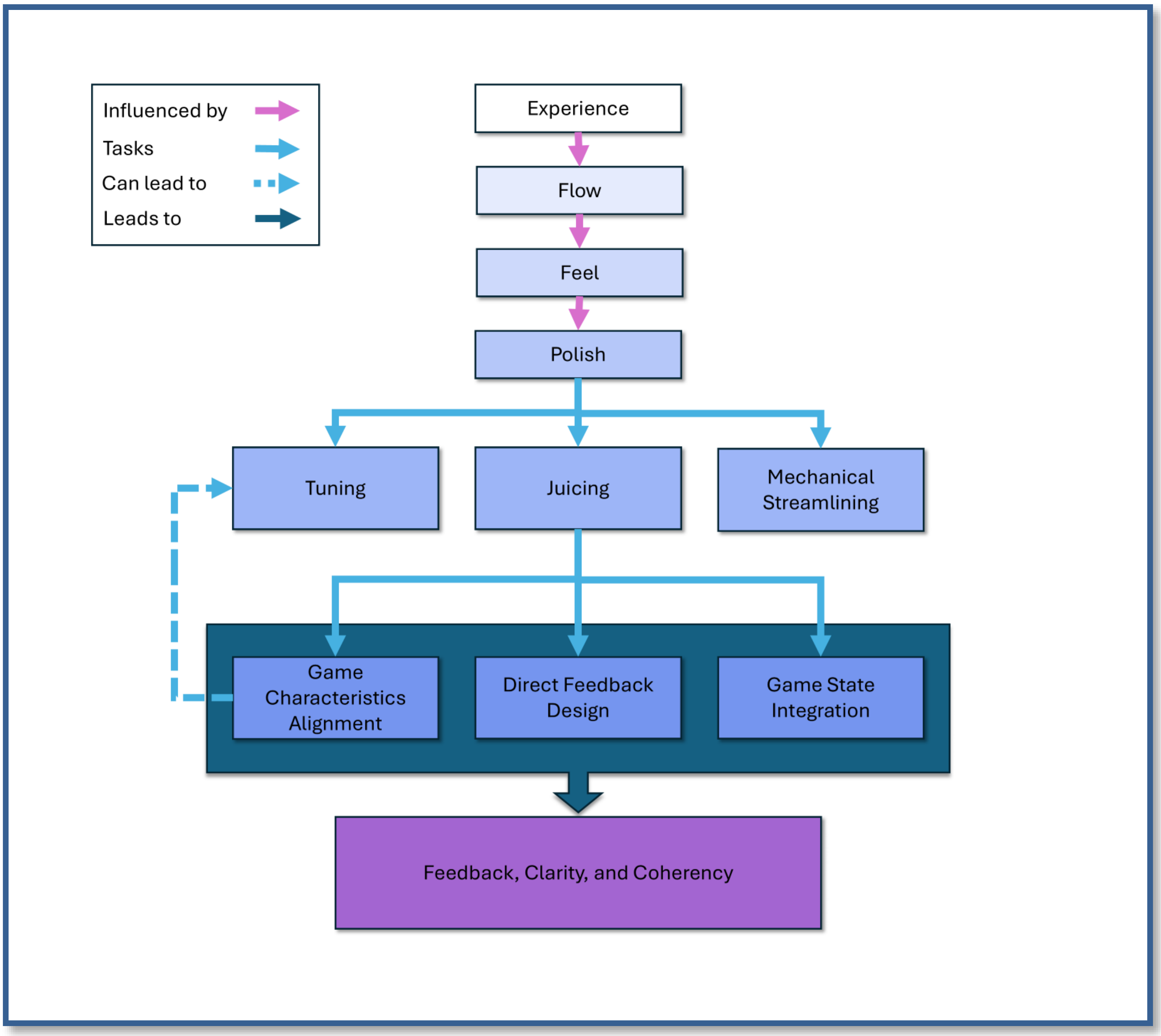

Figure 1: Influence hierarchy leading to juiciness, related tasks and their resulting outcomes based on the framework proposed by Hicks, et al. (Hicks et al., 2018) and the design domains proposed by Pichlmair and Johansen (Pichlmair and Johansen, 2022)

2.5 Juice as a Term

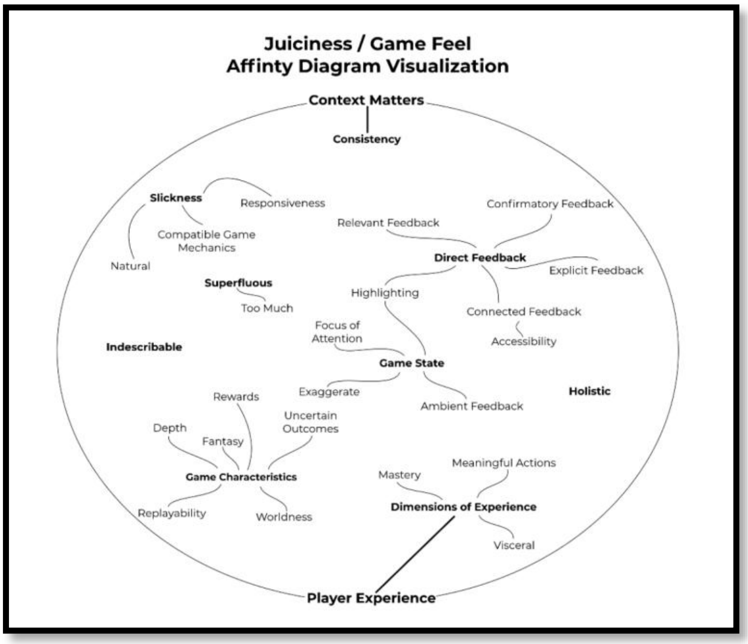

Figure 2: Affinity diagram highlighting key themes from questionnaire responses (Hicks et al., 2018)

By asking developers what they think juice means will likely result in a wide range of different definitions and opinions of what juiciness encompasses as everyone has different opinions. This is demonstrated by Hicks et al. (2018). Where respondents had a wide range of thoughts on the topic, but through a validation process of their framework that included the identified themes, a definition was extracted:

> "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" (Hicks, 2020, p.46).

Hicks et al.'s (2018) definition is a very specific although very verbose. Which does allow us to easily decide what is and what is not juiciness to a very specific degree. Although the use of the word superfluous suggests that there is more feedback than what is needed, but at the same time states this superfluous feedback has a purpose which seems to be contradictory. It is true that games are playable without this extra feedback which means the statement is not wrong. Hicks describes visual embellishments and juiciness in the same terms and refers to sources which suggest that visual embellishments are helpful additions to functional use cases such as informational visual graphs (Hicks et al., 2019). The difference here being that games are not functional in the same sense, because they are meant for entertainment and seek to create an experience. It means that describing similar elements with different underlying goals can be confusing, although games are functional in the way they need the player to understand the rules and actions. Juiciness can be part of the intended experience thus it is not superfluous in the same manner, as it is a requirement to achieve the vision which the developers set out to create in addition to being likely beneficial to the player to learn playing. Thus, this type of wording will be avoided to minimize vagueness of what the term refers to. Additionally, from a usability standpoint Hick's definition is not the easiest to remember or transfer between people with it being long and complex. In practice a shorter to the point definition may be better suited.

As previously mentioned, Pichlmair and Johansen (2022) suggests a definition of the act of juicing; "Juicing is the act of polishing amplification and it results in empowerment and provides clarity of feedback" (Pichlmair and Johansen, 2022, p.138). Though to nonspecialists within game design and user experience this may still contain jargon which such people might be lacking the context to understand. Empowerment here also seems like a strange word to fit. As discussed, juiciness does not seem to be concerned about mechanics in any direct way, instead they seem to be correlated. Though the arguments Pichlmair and Johansen (2022) uses for empowerment within juiciness rely heavily upon fun or strategy and indirect feedback that emerge from the existence of mechanics. The specific examples brough up were bullet time, impact freeze, and charging. Both bullet time and charging are two specific game mechanics which have clear consequences which emerge from them, while impact freeze is a visual effect. These mechanics should not be confused with feedback or juiciness itself. The fact that the player can spend more time shooting during bullet time might empower the player as claimed, but it does not clarify how, or why it happens, if only the player is in slow motion or if it is time itself, how long it will last, and more. From the game juiciness framework, we can quickly identify that bullet time itself is not where the juiciness lies, and the same is true for charging. As for impact freeze, if we break it down into smaller elements, it consists of several feedback elements layered on top of each other which can be identified through the framework. Pichlmair and Johansen (2022) said themselves that it "… is mostly used to signify a successful interaction" (Pichlmair and Johansen, 2022, p.147), meaning it is direct feedback. Because of this difference, the arguments used for bullet time and charging are difficult to apply to impact freeze simply because it is not a mechanic. Thus, their reasoning for using the term empowered seems to be misplaced and therefore, this is an inadequate definition.

In an effort to clarify, and also adding the specific key elements of where juiciness derives from, what it affects, what its goal is, and what the goal achieves, this new definition was created:

Juice

Noun

1. The polished feedback, clarity, and coherency of game elements that aim to improve the game feel and create a sense of flow to heighten the player experience.

This definition contains elements described by Hicks (2020), Pichlmair and Johansen (2022), as well as providing the purpose and desired effect of the polished elements and lastly ties it into its relevant game design domains. This is key to what juice is because without this context one might think a single piece of polished feedback is juice, but it is the entirety of all the elements layered on top of each other designed for a specific purpose which is the juice. Abstracting the words: visual, auditory, and haptic into game elements as this keeps the definition flexible enough to encompass a broader view of what falls under feedback, clarity and coherency. Such as tuning of variables of the game's characteristics, while also keeping out the direct changing of the game's behavior through mechanics, as this should rather fall under game feel than juiciness specifically. This is somewhat of a blurry line of what is a mechanic but using the demo from the pilot study as an example: changing the position or numbers of barrels of a gun does not always require any change of code or mechanics, rather it is how it is used and tuned. Feedback, clarity and coherency also cover the most important elements of learning via multimodal methods without adding new terms such as comprehensibility, cognitive accessibility, immediate legibility, and element interactivity. Lastly, the jargon in this definition is more accessible; flow is a widely accepted and understood concept, game feel, game elements, and player experience are somewhat self-descriptive as they are compound nouns. Feedback, clarity and coherency are also existing terms that are used within and outside of game feel, making this definition accurate, flexible, and accessible.

3 Problem

Hicks has found that juiciness does improve the player experience, specifically with research games developed for testing the research question “does juiciness improve player experience?”. The specific areas observed that had a measurable positive effect on the player experience were visual appeal, and related constructs such as curiosity, immersion and meaning. On the other hand, juiciness did not have any impact on the player experience in terms of needs satisfaction (Hicks, 2020).

> “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 [visual embellishments] in commercially available games, which is also relevant given the large industry interest in the concept.” (Hicks, 2020, p.78)

As Hicks states it would be insightful to learn more about commercially available games as there is a large interest in the concept of juiciness. Therefore, this research has a focus on development in the wild. As such the nature of this research will be in the perspective of what is useful and effective for game development. Testing the juicy design framework in an industry project. Applying it as an analytical and design tool and validate its effectiveness through a player experience questionnaire which contains additional questions for the project in question and specific elements.

Q1. What aspects of the player experience should be part of a playtesting questionnaire that evaluates juiciness?

It then also becomes important to formulate these questions, so they fit the project’s goals and evaluate the juiciness effectiveness, and how to do this is a key to developing the questionnaire.

3.1 Method

This study’s main focus is on the real-world application of Hicks et al.’s juicy design framework. The framework was initially tested on several fully developed titles with all their juiciness implemented, but they stated that:

> “Please note that framework usage is aimed at analyzing games, but does not provide any guidance or specific advice with regards to how to achieve and or implement juiciness.” (Hicks, 2020, p.125).

Therefore, an analysis of the framework was necessary to gain an understanding of the tasks the designer acts on, and how those generated tasks affect the player experience. Additionally, the tasks further clarify what is within and outside the scope of juiciness. This analysis methodology was partly guided by the resulting data from the pilot study, and the other part was informed by the background. Then finally to validate the implementation, the resulting design within the game was tested against itself in an A/B playtest to evaluate the improvements, and potential over-design issues. The questionnaire given to the testers were also validated in the pilot study through testing, which produced a wider understanding of the sampled data and what data types should be included.

The data that this method aims to collect is mainly reported emotional and sensory data, coupled with elaborations on those experiences. How does the player respond to the game feel, visuals, audio, and haptics in the specific case of juiciness and additionally open-ended feedback. In other words, how they respond to the designed elements which aim to create coherency, clarity and feedback. With this type of data, we are trying to avoid data generated from expertise as this method ideally should work on any player type, experienced and inexperienced. Although a player's experience in gaming may sway or influence what their thoughts are on intuitiveness and change their player experience. A/B testing is then utilized to mitigate this issue so there is a measurable difference we are looking at rather than just the experience data itself. The collected data is then both quantitative and qualitative. It is partly numerical, but the numbers being measured come from a person's qualitative opinions, where those opinions are also recorded in the free text questions where they are described in better detail if there is any. When the questionnaire is asking for written responses, we are not looking for them to come up with design solutions for us but highlight what they think is the issue which will then be analyzed in relation to the rest of the data. It may turn out they were right, partially right, wrong, or right; but what they said was not aligned with the design vision. Thus, the respondent expertise is not necessarily a relevant factor as we are evaluating our design and not their proposed design to see if they understand our design. Thus, the final analysis is also a partly qualitative conclusion as the designer has to make informed decisions based on the results rather than the results themselves giving a clear answer in every situation, although it is possible to get some clear answers purely from the raw data.

The testers themselves were sampled by convenience, meaning that all of them has played many games before as they were game students and gamers. Although this may have influenced the understanding of certain game elements as they have familiarity with games in general and expectations of how certain mechanics should work, it should have a minimal influence on the results. This is because the data that is being measured here is not expertise or familiarity, it is the persons feelings during the experience. People know when they are bored or what they are feeling without understanding what a game mechanic is. There are only a couple of the free text questions which asks for a rationale where expertise could play a larger role, meaning that whatever relevant expertise these students may have is minimally influencing the results overall. What likely plays a bigger role is personality which is not something that can be easily be considered. Especially if the aim is to be as close to a real development scenario, because developers would likely use their player base which would comprise of people with personality traits that likes this type of game, but in this case, we do not have access to said player base. Furthermore, because of the data type we are measuring here being emotions, these types of player profiles may not be as applicable as it may seem.

> "Profiles compiled from the way you interact naturally with a virtual world can be used to assess your vulnerability to different cheap psychological tricks. You might be a sucker for scarcity but impervious to framing effects. You might be prone to illusory correlation but only occasionally consumed by the Zeigarnik effect. These vulnerabilities can then be targeted by bespoke interventions." (Bartle, 2025, p.479)

As the goal of the juiciness is not to use any particular psychological tricks to take advantage of a set of behaviours, the use of profiles as a general way to validate the responses of the juiciness questionnaire becomes less relevant as the profiles may be too specific and out of scope. We are aiming for something which players will intuitively understand regardless of personality. Although, an argument could be made for profiles for learning strategies, but that is also outside of the scope of this research as this research is not concerned with what types of people learn the best from certain types of juiciness. Where it may be useful as previously stated is if the game being tested is something the tester likes to play, but this is a wider problem where we cannot fully ensure that testers are within the intended audience when we do not know the audience.

Regardless of someone's familiarity with games in a broad spectrum they still have to learn the specific game's rules and mechanics even if some are similar to other existing games. None of the participants were familiar with the demo in the pilot study, nor Northrak's game. Meaning that the answers provided was based on pure first impressions, just like any other person might download and try a free demo from an unfamiliar new game. Similarly indie game developers might not have a big community to playtest their games and use what resources they have that are convenient for them such as family and friends.

3.1.1 Ethical Considerations

Firstly, lets address the main problem with juiciness: operant conditioning. As juiciness is part of game feel, the goal of juiciness is to create clarity and coherency; when these additional elements are added in a supporting manner it will improve the feeling of the game and be more satisfying. Which is what needs to be discussed, can this be used to such a degree to turn operant conditioning into a dark pattern through juiciness? Operant conditioning will be part of a game's design in one way or another, either used for good or bad. Gabe Newell briefly mentions reinforcement theory when talking about how they defined fun as "The degrees of which the game recognizes and responds to the players' choices and actions" (Valve, 2023, 16:03), then he expands on that with the behavioural theory, what is being reinforced and how the reinforcement schedules where, because that was a useful way of making design decisions. What Newell is discussing here is in some way the early stage of juiciness as he describes the design concepts he used as:

> "I was trying to convey to the user a sense of yes, you were making choices. Yes, you were progressing, which meant that the game had to acknowledge that back view. If you shoot at a wall, there have to be decals. If you kill a bunch of marines, the marines have to run away from you. Right? You have to have this sense of the game acknowledging and responding to the choices and actions and progressions that you've made. Otherwise, it loses any sort of impact." (Valve, 2023, 16:37)

Newell in some way thinks that reinforcement schedules should be part of the design process because that's how you create what they defined as fun, but others are not as much in agreement to this kind of view, such as Bartle (2025). In "Designing Virtual Worlds: Volume I; Second Edition" (Bartle, 2025), during the chapter "Virtual Worlds' Take on Psychology" Bartle discusses how certain psychology favours the player and places different concepts under "Favouring the player", "Natural, disfavouring the player", or "Unnatural, disfavouring the player" where operant conditioning is under the latter.

> "Whether you like it or not, you're going to have all four reinforcement schedules in virtual worlds, even in social ones. They're also ubiquitous in Reality, though, so I could have classified operant conditioning as "natural, disfavouring the player". That I didn't is because when it's used in an unnatural fashion it heavily disfavours the player. Variable-ratio reinforcement schedules for rewards are very moreish. Moreish does not

> mean fun, though, and designers want people to play their games for fun, not for mind- controlled reasons. Putting deliberate variable-ratio reinforcement schedules for rewards into games will keep people playing, but not for fun. Many designers regard designing games around them as immoral, but their employers might argue otherwise on the basis that they want a money mine." (Bartle, 2025, p.477)

This is a discussion which people may agree more or less with certain aspects of how operant conditioning is being used and it seems Bartle also falls under this line of thinking as he says moreish does not mean fun but then does not leave out the possibility that operant conditioning can create fun. The clue here is what he refers to as natural and unnatural uses of it, but what exactly falls under natural use of operant conditioning? Is it all operant conditioning which emerges from a design by nature of the design, or is it also operant conditioning which does not attempt to trick or take advantage of the player to spend more than what they want to either if it is time or money?

> "Because operant conditioning makes great use of rewards and players stick with them for extended periods, this explains why many psychologists regard virtual worlds as addictive. They may overstate the magnitude of the problem, but the thrust of their argument does hold true: operant conditioning can indeed lead to psychological problems for some players, and developers who knowingly use the technique above natural levels without taking precautionary measures are asking to be sued." (Bartle, 2025, p.478)

Bartle discusses how operant conditioning in the case of gambling is simply not fun and states that players dislike it and so avoid the operant conditioning, although removing it all also means destroying the game loop, so it has to be in some sort of a balance. So, it is then clear what Bartle thinks is unnatural use of operant conditioning, which is as he puts it while talking about profiling which is, it is bad when it is attempting to take advantage of cheap psychological tricks. In other words, the game loop is the core of the game and is (hopefully) not trying to take advantage of any tricks at its base, and so building a good game loop with operant conditioning and rewards is a good idea, and maybe something you should do according to Newell. As Bartle says it is ubiquitous to reality, and Newell says that realistic games are not interesting and so not fun which was the motivation to create their definition of fun, which relies on operant conditioning in some basic form. This seems to confirm what Bartle says that games need it to be fun in the first place. So as stated, the key to this seems to be that using operant conditioning turns bad once its goal is to elevate another dark design pattern. Which in turn means that juiciness would not be a bad use of operant conditioning as its goal is to elevate the experience itself which likely is an artistic goal and not one to squeeze time and money out of the player.

3.1.2 Identified Tasks of The Game Juiciness Framework

As stated, the framework generated by Hicks et al. (2019) was not intended for designing juiciness, but for analysis (Hicks, 2020). The tasks which were identified through cross analysis of the game feel domains by Pichlmair and Johansen (2022) and this framework was the following: Alignment, Design, and Integration. These three tasks seek to clarify the goals of each section, in an attempt to further guide the designer and create a wholistic understanding of the process. As discussed in the domains and framework overlaps, the final descriptions of the juice tasks are:

Game Characteristics Alignment tasks aim to create coherency across several game elements. It touches mainly on visual identity, theme, and logic. Logic in this sense means that it is using a consistent logic throughout which it has defined through gameplay, and logic as how things are expected to behave by intuition. The alignment process can occasionally lead to tuning tasks which then aligns the characteristics as all that may need to be done is the tweaking of some variables on behaviours.

Game State Integration is mainly about the game world and clarity which affects the player's ability to take informed decisions. The Game State should then be integrated into the relevant areas of the game world and specific game elements which has differing states which changes over time or by mechanics. Where it can draw attention to the correct elements at the correct points in time as their states change or continuously update to give additional information to the player.

Direct Feedback Design covers the remaining tasks which are often about immediate feedback, which focuses on how the player receives feedback. Several game elements and mechanics provide feedback by virtue of being interactable, this is to say that the feedback which emerges naturally from interactions with mechanics is not Direct Feedback as this feedback is already present. Rather Direct Feedback builds on top, further adding clarity and coherency to existing game elements.

3.1.3 Measuring and Evaluating Juiciness

Juice is not a single faceted concept, it is part of the player experience, it influences flow, and game feel. Without any questionnaire which aims to measure juiciness it may be difficult to draw conclusions from questionnaires that only measure the specific components of which juiciness is a part of. This study uses an exploratory questionnaire to attempt to solve this problem, keeping the player experience at its core and using codes selected from the Presence Questionnaire by Witmer and Singer (1998) to help identify problem types together with the juicing tasks to suggest which tasks may be performed and how to improve the scores. As stated, the codes are taken from the Presence Questionnaire because what is trying to be measured here and what Witmer and Singer is trying to measure aligns very well. Their argument for using their approach is as follows:

> "Our argument that presence depends on the ability to focus on one meaningful, coherent VE [Virtual Environment] stimulus set is similar to McGreevy's (1992) concept that the experience of presence is based in attention to continuities, connectedness, and coherence of the stimulus flow. The coherence of the VE characteristics and stimuli thus enables the focusing of attention, but does not force that on the experiencer. This concept of enabling without forcing distinguishes the experience of presence from the factors that typically support the experience." (Witmer and Singer, 1998, p.226)

In this argument there are several key concepts that are important in juiciness, thus using a similar analysis and coding should be reasonably compatible.

Because of this approach, analysis of the resulting data is a required step which must be performed since the questionnaire cannot output a single variable which states what is wrong. It measures several variables that must be interpreted and evaluated against the game it is testing. Then it is advised that the interpreter has a well-rounded understanding of the game itself and the presence factors.

Control Factor	Sensory Factor	Distraction Factor	Realism Factor
Degree of control	Sensory modality	Isolation	Scene realism
Immediacy of control	Environmental richness	Selective attention	Information consistent with objective world
Anticipation of events	Multimodal presentation	Interface awareness	Meaningfulness of experience
Mode of control	Consistency of multimodal information		Separation anxiety / disorientation
Physical environment modifiability	Degree of movement perception		
	Active Search		

Table 4: The factors which Witmer and Singer hypothesized contributed to the senses of presence (Witmer and Singer, 1998, p.226)

3.1.4 Pilot Study

As this research is exploring how questionnaires should be designed when validating juiciness, a pilot study is highly recommended. Therefore, a short pilot was conducted to evaluate which questionnaires are the most appropriate and test the balance of standardization and tailored questions. In this pursuit the pilot study had three types of questionnaires.

- Mixed Standardized Questionnaire (MSQ)
- Tailored Questionnaire (TQ)
- Standardized and Tailored Questions (STQ)

The mixed standardized questionnaire is comprised of questions taken from several standardized questionnaires that can be used to measure player experience, flow, presence, and player enjoyment. To keep the questionnaire at a reasonable length, three standard questionnaires and guides were selected: The Game Experience Questionnaire (IJsselsteijn et al., 2013), A Presence Questionnaire (Witmer and Singer, 1998), and A Model for Evaluating Player Enjoyment in Games (Sweetser and Wyeth, 2005)

The Mixed Standard Questionnaire was created by reviewing the relevant existing questionnaires, evaluating the individual questions if they are applicable to the framework. The questions derived from the player enjoyment model were formulated from the criteria listed for each of the relevant elements which did not already have existing questions.

The Tailored Questionnaire is comprised by specific questions that could be derived from the game juiciness framework together with the listed elements from the demo's GitHub readme. This is to simulate how playtesting questionnaires are made as they are all unique to the game as most games do not have identical mechanics, visuals, audio, or experience.

Lastly a few questions with written answers were added to fill in the missing aspects which the generated questions did not fill.

The final questionnaire is then a combination of game specific questions and questions from standardized questionnaires. This version did not have the free text written questions as these were added to the Tailored Questionnaire after the pilot testing had begun by implementing some feedback from the respondents.

The target game for this pilot is a demo created by Hallgeir Løkken which aims to teach some elements which improves the game feel in a prototype. This demo is used because it can showcase the difference with and without several elements such as visual and audio effects, animations, and specific game design which changes the game feel. Using this demo allows the pilot study to be conducted sooner rather than developing a demo or doing changes to an existing game, because it already has mechanics to remove and add juiciness step by step or all at once. This mechanic in the demo is what will be used to let players test the game with different amounts of juiciness.

The demo itself is a simple 2D top-down shooter where the only mechanics are aim & shoot with the mouse, and movement with WASD, together with simplified graphics.

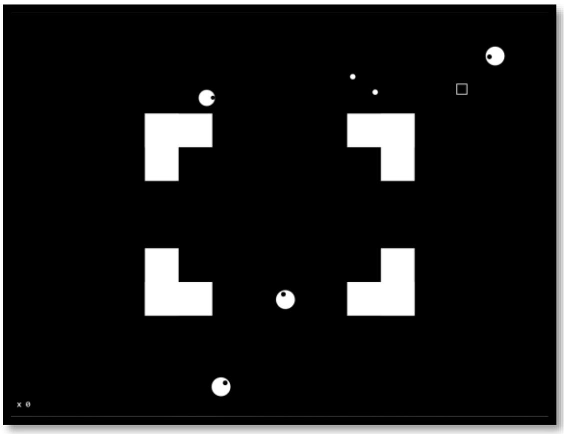

Figure 3: JUICYDEMO with no juice

Figure 4: JUICYDEMO with all the juice

The elements that can be added or removed in sequence, but in no particular ranking in importance are cool gun, more shooting, visualization, sound effects, particles, animations, screenshake, colors, music, more particles, UI animations, and craziness (Løkken, 2023) (Appendix D). These elements cover the key aspects for the questionnaires: genre specific mechanics, visual feedback, audio feedback, direct feedback, coherency between elements, state changes, state understanding, distracting elements, level of importance, and highlighting correct elements.

The pilot study procedure is the same as the main study's procedure except for that players are assigned one of the three questionnaire types which they answer the one given after two tests. The two questionnaires are separated to keep track of responses with and without juice. The procedure for the pilot was as follows:

- Assign the subject one of the questionnaires: MSQ, TQ, or STQ.
- The tester plays the demo with minimal juice
- The tester answers the questionnaire for the first time

- The tester plays the demo with maximal juice
- The tester answers the questionnaire for the second time
- A short interview with the tester to elaborate on which questions they did not fully understand, did not fit, thoughts on the length of the questionnaire, and any last thoughts.

With the demo being as simple as it is the testers were told to play as long as they felt, while how long they played was measured and recorded.

3.1.5 Pilot Conclusions

All of the different questionnaire methods produced valuable information, but the one which combined tailored, standard and free text questions was the most useful as then the data could be analyzed as a whole. In other words, STQ was the most useful method tested which produced desired results. The tailored questions were able to highlight the specific elements and what the difference was but lacked data which showed the underlying issues. The opposite was true for the standard questions; the data itself could not pinpoint what mechanics or elements beyond visual or audio were problematic. It was better at pinpointing the underlying issues derived from control factors, sensory factors, distraction factors, and realism factors. Additionally, the written answer questions further filled in the specificity of elements which were not mentioned in the questionnaires. Analyzing the data with only the lens of qualitative data and knowledge of the demo and its contents in order to pinpoint the exact problematic elements was difficult although possible with informed design knowledge, but all the data together was more desired for the analysis.

Questionnaires that aim to measure the effectiveness of juiciness and identify problematic elements should then contain a mix of questions designed to collect both qualitative and quantitative data. Street (2017) says that it is important to be careful when analysing data, as sometimes you have to ignore the data because it is not always representative of the balance philosophy (Street, 2017). This advice seems to be useful in this context as well although it does not fit our scenario exactly because we also have qualitative data. If there were only quantitative data, we should know when to look at it to understand something is wrong but know when to ignore it to pinpoint the issues ourselves. As said, the written answers may also help in pinpointing the exact issues, but it will become a more time-consuming endeavor with large datasets. Players may also incorrectly identify the core of the issue they experience so Street's statement may still be something to keep in mind. It is then important to understand that the written answers have an inherently different function to the other questions. Thus, removing them removes a key element which is direct player feedback. It is then the combination of measuring the player experience and gathering player feedback that enhances the usefulness of the data. This is to say that if there is no player feedback, the people who are doing the analysis to identify problematic elements require a deep familiarity with the game. In contrast analyzing if the tested elements improved the experience does not require this deeper game familiarity. In practice this means that the aim, time constraints and expertise affect how the questionnaire should be structured although it is recommended that it contains all three elements: standard questions, tailored questions, and player feedback (written answers). Where the most important element is the player feedback.

3.1.6 The Final Questionnaire

To reiterate, the version of the questionnaire in the appendix (Appendix A) has specific questions tailored to the demo of *Close To Flight*. For further use in other projects these questions should be removed and replaced with appropriate questions for the purpose of the test.

The final questionnaire is a mix of several questionnaires with unique additions for the specifics of the game in question. The method of which these questions were selected was filtering which questions asked the same questions. The ones who were too similar or identical got removed. The pilot study's results showed that the questions that were gathered was effective in its goal and highlighted the importance of the procedure on how the tailored questions were created. The entire questionnaire is provided here to additionally provide the tailored questions as a guide to what they should look like as well as listing the standard questions. Some of which may still need some revision to be the best they could be. Specifically, game design terms such as game state may be wise to avoid, or state in general. Because players may not be familiar with these design terms, and to some extent even some developers may not be familiar them or have the same understanding, such as the case of juiciness (Hicks et al., 2018). Although with that said there may still be value in keeping some design terms as some will be able to infer the meaning, but pinpointing which terms are understood by the target group is not within the scope of this questionnaire so there is no claim that design terms are always a bad idea, just that some terms may not be understood so be aware of their use.

3.1.7 The Final Procedure

The final testing procedure was different from the pilot testing by that each tester did not play both versions and did not answer the questionnaire twice. Additionally, they were not monitored or interviewed, unlike the pilot test where the goal was to evaluate the test procedure, so this step was left out to not make the play testers feel like they were watched over to have them act and think more naturally. This also means that they were not guided during the playtesting in any capacity as there was no observer. The testers where then selected to play *Close To Flight* with and without the VFX designed to add juiciness. These versions were referred to as A and B, where A is unjuiced and B were juiced. Once they had played through their assigned build of the game both groups answered identical questionnaires by themselves.

Each question which was tailored specifically to *Close To Flight's* demo was additionally coded with what design task the question was derived from in order to more easily identify which tasks may still be left to improve the juiciness further. The written answers of the questionnaire naturally do not have a ranking value and thus did not affect the numerical outputs but rather helps identify problem areas. By extension of this, these questions asked for clarification on what may be causing bad experiences within the play test. These questions should then address previously known issues.

3.1.8 Data Analysis

The data analysis was conducted through a cross evaluation of the standard, tailored, and free text answers. Which the process itself was deductive from the statistics and qualitative data. To aid this process, all the raw data was processed by collecting the averages of each answer separately for the A and B tests. These two averages where then compared against each other to get an 'improvement' factor. Had there been time, an average deviation would also be present here for the improvement factor. Depending on if the question has a negative effect, the improvement factor calculation was inverted such that a high improvement factor is always desired. Then these tree variables were then the main statistics used to make the figures 8-12 in Appendix B. These figures visually represent the average answers for each question in both A and B tests while adding the resulting improvement factor on top. The resulting figures where then used as a starting point for the analysis where the next step was the design intent of the juiciness which was additionally defined by the coding. By cross referencing the issues identified during the analysis, and thus the created design, and the resulting questions created for the questionnaire we can try and observe differences in the senses the player had and how the implementations affected them. As previously stated, the tailored questions were good at validating the implementation itself, but the standard questions are good at analysing underlying influences. Take question TR 2: “I knew when the grapple failed” (Appendix A) as an example. It is coded with direct feedback and control factor. We then look at those factors in the standardised questions to see if we find an improvement which supports the same improvement as the tailored question implies. If there are any discrepancies that may mean that the specific element might have been improved, but it did not contribute to the overall experience. Such a case may be analysed as over juicing or did not grab the attention it needed to be effective. In which case questions which affect attention and distractions should be closer examined in this context. However, with good free text answers some of this deeper examination of the factors may not be needed as these questions would aim to have players fill in the missing parts here. Although one should not rely on a single text answer by itself. Players are not always accurate in their observations of what the problem is, but their feelings are what we are looking for. Something being difficult to see might not be its too small, but its blending into the background too much or another cause. Analysing what the player is saying is key then but be aware that the answer might express one or several codes that have not been applied to the question. Just how if the tailored question and standard question data does not seem to support each other, the wrong problem might have been treated, or there might be influences by other codes which are not measured by the tailored questions. With this approach we can pinpoint if implementations are lacking something and or achieving their goals. The remaining variables which score low then becomes a guide on which types of elements are missing, or contradicting existing design, and another analysis should take place with these in consideration.

3.2 Close To Flight

The game used in the study is called *Close To Flight*, a game in its pre-alpha stages developed by Northrak. On their website they describe the game like this:

> “In this “Flight” hearted adventure, a wingless owl is determined to overcome their limits by learning more about the world, exploring uncharted islands, helping others to reach their goals, and finally achieve their dream: to be able to fly! This cozy coming-of-age journey takes you to far off lands through a story of dreams, friendship and community.” (Northrak, 2025)

As they describe it is a game where the player takes the role of an owl that cannot fly but instead is using a grappling hook to get to where they need in a world where flying is a given. Which makes the world the owls live in a difficult place to live and contribute to the community without the ability to be as free as the ones who can fly. The game is a 3d, 3rd person platformer game with a grappling hook with upgradable segments which tackle different obstacles and challenges.

The grapple hook works such as it can be shot out to hook onto surfaces, once it is attached it functions like a rope you can swing from, but the player has the ability to reel themselves up and down while it is hooked to a surface.

The player also has the ability to double jump that gives them a little freedom, but without the grapple hook movement is very limited.

In the demo there are also collectibles which guide the player in certain ways. These collectibles are represented by floating sparkling feathers. As a player collects it, a saving icon is displayed on the bottom right of the screen to indicate the game registered the collectible.

The game also has NPCs which the player can talk with to get quests, game information or story. Part of the tutorial is delivered to the player by having a character explain what the buttons do and how to play.

Figure 5: In game screenshot of Close To Flight where the player is swinging using the grapple hook (Northrak, 2025)

Figure 6: In game screenshot of Close To Flight where the player is double jumping across the environment (Northrak, 2025)

The visual effects that were developed for the study was all related to player abilities such as using the grapple hook; when it successfully and fails to hook onto a surface, when the player is reeling themselves up or down, when the rope of the grapple hook has reached the maximum length and minimum length, which direction the player is moving while reeling, and how fast and where the player was moving from. Then the last effect was for the feather collectible to try to clarify its purpose and importance.

Figure 7: A feather collectible in the game Close To Flight (Northrak, 2025)

4 Results

The results greatly lean on to a positive improvement in general, although there are still some issues which persist. For further information on the resulting data have a closer look at appendix A, and B. Through the written feedback we get a better understanding of what still persists besides the clear dislike of the collectible feathers. The issue with them is that players are not understanding their purpose and is confusing them with checkpoints, possibly due to misaligned game characteristics.

The grapple hook feedback is better but not good enough and need to have more multimodal feedback such as audio, be more visible and distinctive, and vibration for controllers. Players also had difficulties telling which parts of the environment they could use the grapple hook on. One respondent even suggested to give them total freedom as it was too frustrating not understanding the difference between valid and invalid surfaces. Another respondent suggested to do something similar to the game *Portal* (2007) where portals can only be placed on the white walls. Respondents also voiced that while swinging with high speeds the player trail dust particles had issues and were difficult to use as a speed indication as they were intended. Another respondent also commented on that the successful and failed grapple VFX was too similar without elaborating which elements was too similar. Assumedly they meant they are both circular and white, thus changing either the colour or their visual shape could help to make them more distinct. Lastly none of the players mentioned it, but the results shows that they did not feel the impact of the minimum and maximum grapple length VFX, that may be due to them never triggering them although we cannot say that for sure as they were not asked if they saw them meaning that they need more testing, and likely need to be more visible and feel more impactful.

The last major negative that showed up in the written answers was distractions such as either a bug, the level killing or resetting the player unexpectedly, still missing feedback, and controls. These frustrations might have caused them to be less immersed, making them more aware of the control device and user interface (SR56), feel frustrated (SR48), feel less of a challenge (SR83), feel more bored (SR39) and less successful (SR40) (Appendix B, figure 8-12).

The negative results from the standardized questions shows that distraction factors were an issue four times, control factors three times, sensory and realism factors two times each. Meanwhile in the tailored questions realism factor had a count of four, control factor was two, and sensory factor was only once, while there were no distraction factors. The main pain point here was the feather collectibles, and a small negative impact on the grapple and game state understanding, which highlights that the main issue is game state integration. This is supported by most of the written feedback stating they were confused, that there were missing info, and wished there was more feedback.

In all the data suggests that the collectible feather feedback may contradict conventional game design resulting in misaligned game characteristics and causing confusion. There is missing game state integration to make players understand what game elements do and how to interact with the game world. And lastly there are still more direct feedback to be designed for actions.

The majority of the data shows positive results by the implementation of the VFX. Because it is difficult to derive actionables from positives and what is not an issue which is why there is a bigger focus on the negative impacts and the low ranked answers. With that said there is a high number of questions which averages close to 2. Only 13 of 84 questions ranked 1.4 or lower, and 19 questions ranked 2.8 or higher (accounting for reversed ranges). Giving us 22.6% mostly positive, 15.4% mostly negative, and the remaining 62% being mostly neutral or moderate. These lower ranked questions are more widely agreed by the players that they are bad as there is less variation of answers between the 0-2 range than there are in the 2-4 range. With the focus on mainly negative results one could say there is then only 15.4% problematic elements in the results, but the nature of the standardized questions is not to highlight negatives, but rather to measure presence and effectiveness of the player experience. Meaning we want as high numbers as possible.

So, with that in mind there are a lot of improvements which can be made, but a very bad 15.4% which is detrimental to the game and should be fixed as soon as possible, and more vague improvements to be made elsewhere which was not highlighted during this test but might become more prevalent as the game is iterated upon.

5 Discussion

The validation of juiciness is something which is not a focus by most research on juiciness. They are more concerned about how to design it or what it is to begin with, which are all topics covered here. Several sources of game feel and juiciness research were pulled in to use as a guide to how to design and conduct analysis, combining compatible concepts and drawing new lines between the research. The additional context provided by more recent findings in human cognitive architecture has revealed that there are different types of multimodal information which can help or prevent learning depending on how it is presented. This is especially important for games as they are usually a multimodal medium containing sound, visuals, and physical actions through control devices. By the nature of games, juiciness is then the design of multimodal learning within an interactive medium. Giving us the words to describe what a lot of visual effects aim to do; teach the player about the world and actions within the game. If we view games through the lens of operant conditioning, then juiciness becomes one of the tools designers have to enhance the operant conditioning to make players behave in the manner they want by teaching them what are rewards and not so they can execute the gameplay. A lot of things can be a reward such as pretty visuals, a good story moment, an item, a periodic/temporary upgrade and the list goes on. The player needs to perform the correct actions to achieve these goals which more often than not are communicated through feedback and juiciness. Conceptually this lines up with reward schedules, smaller rewards lead to a bigger one. The actions which are rewarding to the player through juiciness leads them to bigger rewards, teaching them what is good and bad in an entertaining methodology, and not in a manipulative one. One can think of it as setting up the conditions for operant conditioning to function more similarly to the real world.

The juiciness tasks are meant to improve feedback, clarity and coherency, which overlap with some each other meaning that one bigger and wider task may be able to be extracted by having a wider view as they relate to each other; either polish or something else. The generated design tasks for the project should go through a validation process to check which tasks are the same but from different perspectives. Here ask the questions “which tasks are no longer valid once only one of these tasks are complete?”, “What is the primary control condition causing the problem?”, “Which tasks are implementing the same primary control condition but by different means?”. If any tasks address the same control condition, in other words, they serve to create the main method of which the juiciness carries information to the player, then these tasks are invalid and need to be cut or repurposed into different compatible tasks. Some simpler questions to help guide this process could be “what is this implementation aiming to teach the player and why?” and “how is this supporting the existing implementations in a new additive way?”. Once tasks are defined and executed the juiciness validation process can begin. During this playtesting session players should be given a standardized questionnaire together with tailored questions specifically to the game and this playtest to validate the effectiveness of the completed tasks. These questions should include both ranked questions in a range and written answers. This is to give players the opportunity to highlight something which the designers might not have thought about or elaborate on why a problem still persists. They should avoid using game design and programming terms as not all players will understand the meaning in the context they are used, from unfamiliarity with the terms or lack of correct context.

To put more emphasis on newer academic research on human cognitive architecture and how humans learn from multimodal stimuli as it became a key for filtering design tasks in the process described above; this research has better highlighted lesser understood mechanisms of juiciness. With it a better starting point for analysis and design can be utilized. Although it is still a quickly evolving field, both cognitive theory and juiciness; one can expect there to be old information out there which may be more or less correct, and so one should consider new research alongside widely cited material to cover recent discoveries and point out inaccuracies in older material. Especially now, while publications are made almost every year. The intersection of these two fields seems to be the right direction for juiciness research so we should keep a keen eye on it to mix the two fields. Which also means in this lies some of the limitations of this paper as well. There may be details which prove to be inaccurate later down the line by the nature that current research has differing results and are not solidified or widely accepted yet.

Using juiciness, games in the future might turn even more addictive from the fact that they support reward schedules which is a part of conditioning, but one could argue that only games which intentionally use theory to take advantage of cognitive functions of people for their own gain instead of using it to make a fun, enriching or otherwise valuable experience, will do so regardless of which theories are out there. Making games feel better is also not comparable to how substances make you "feel better" in the sense that they are addictive. What is meant by feeling better here is vastly different. Juiciness makes the game feel better to interact with which is not the same. But one could argue that gambling games are perhaps as addictive as substances, making them juicy surely heightens that experience. And that may be, but in the case of gambling it is different cognitive functions which are being taken advantage of than what juiciness does. Risk aversion is not the same as visual embellishments, as it were.

5.1 Limitations

The main limitation of this paper is that convenience sampling was used, which as stated means that the testers are students are part of an academic games study. Thus, they might have a specific approach to analysing their experience or different first-hand impressions of games which is a clear issue which is not perfectly addressed here. Although in an attempt to minimize this with the data collection method with both triangulation with differing types of data which are: (1) sampling possible perceived issues by the researcher through the tailored questions for the game and everything different that is different between the versions between the A and B tests, (2) getting play tester feedback where their opinions can be analysed of what they experienced, where these questions asks the player to put a question to relevant game elements they might have missed. And (3) statistical data of their reported experience. Unless the respondents are inaccurate in reporting their experience these questions do not leave much if any room for interpretation from experience, but perhaps emotional intelligence and awareness of what they were feeling. Although that would be outside of the scope of this research and would be more on the validity of self-reporting experiences as research. Although, the purpose of this kind of feedback collection is to improve the developed visual effects, were having experienced testers in that pursuit can be beneficial, but having a varied point of view gives us more data to work from. Especially as an unexperienced eye can point out something an expert might have overlooked. Secondly as this is aimed to be during development, one can normally expect that the experts are the ones on the team developing and so these questionnaires are aimed at the players to begin with which is this papers weakness as the testers were more experienced in game development than regular consumer level players.

6 Conclusions

It was found that the juiciness framework by Hicks et al. (2018) is good for analysis; as they suggest, but also additionally a good tool to aid design. Often one has to analyze in order to create a well thought out design and the framework helps to point the designer in the correct direction. Inserting the concepts and language that Pichlmair and Johansen (2022) propose for easier discussion and design of game feel enhanced the juiciness framework and created a more rounded understanding of what it means to design for juiciness and what falls outside of it. Which is useful once a designer is trying to figure out the core of the problem that they are trying to solve. With more recent research on cognitive theory, we have clearer evidence that juiciness does in fact support the player during gameplay even if the additions of it may seem redundant or superfluous as previously described by others. It may not always be crucial for a technically functioning game, but games are not tools to serve a purpose like other software are, like for example figuring out how strong a bike frame is through a simulation. Games are experiences and do not produce an end product in such a manner. Thus, the underlying theory and design should not treat it as such. One could even say one needs juiciness to make a fun game, as some of the interactive elements in the game needs to give the correct feedback which is part of making a fun and rewarding game at its core and so it is not an optional additional element.

As stated, the combination of the design domains and the juiciness framework resulted in a deeper understanding, but specifically of which types of tasks a designer must complete in order to create juiciness which serves its purpose in supporting the player in differing ways. Game Characteristics Alignment is important for the players understanding of the game world and mechanics as a whole. They need to understand how one mechanic interacts with another which should make sense within the game world. Game State Integration focuses on giving players access to information which normally would be hidden without specifically creating systems to reveal that info. This leads to the player being able to make informed decisions based on the game's state, helping them play the game in the way they want to play, and gain an understanding of what is possible and isn't possible. Lastly, Direct Feedback Design aids players to learn what their inputs and actions results in. In the real world we can for example feel pain and see blood coming from a wound if we do something that hurts us, or wood chips coming from a chainsaw as we saw into a tree. Just how a craftsman learns how to chisel a stone from how the stone reacts to the chisel and hammer, a player learns how to play a game from how it reacts by its juiciness. These are small hints we use to understand our action was effective towards our set goals. That's how these tasks assist designers as the specific tasks describe what kind of multimodal information should be present without making them overwhelming and overlapping into redundancy so that they correctly support multimodal learning.

The understanding of where these tasks come from and what they effect has improved the analysis process for quality assurance of the juiciness. The resulting process to develop juiciness was an iterative process just like what Fullerton (2019) describes. No additional steps here are needed as the results from the analysis via the framework should give the designer an idea of what kind of tasks are required to improve the juiciness as shown in figure 1. The questionnaire data, all together with the standard questions allows for a better understanding of what the players are experiencing, which should be used in the next iteration of the process down the line to inform the next design tasks.

With these final results we have a fair foundation for this process using the game juiciness framework for both design and analysis, with a wider and more connected understanding of juiciness. Merging game feel and juiciness design with cognitive theory, by using juiciness design domains to generate tasks, was effective in creating quality assurance questionnaires. Which validates juiciness in the game by measuring the effectiveness of specific elements, collecting feedback, and the player experience. The contents of the questionnaire should be (1) derived from the design process and using its design decisions as a base to generate the questions, where the design theory builds the foundation. (2) Free text feedback to fill in inaccuracies, missed points and capture elaborations. (3) Standardized questions measuring the player experience, or in this version, both player presence and experience. These three together functions as differing data types which can more effectively triangulate problem areas by applying the coding and analysis method proposed by Witmer and Singer (1998) to generalize the types of experiences the questions were sampling.

As discussed, the questionnaire should preferably not use any game design terms and only focus on descriptions which anyone can understand that is not proficient in games. The tailored questions themselves should be formulated from the tasks which was performed so that they properly sample the correct visuals. They should also ask several questions about the same visual, because as mentioned one task may affect several things which should also be reflected in the questionnaire.

Some of the tailored written questions turned out to be generic enough that they could apply to most games. So assumedly there is also space for standard written questions. How many of these standard written questions there could be remains unknown. Although multimodal redundancy might inform what some of them might be.

6.1 Summary

Juiciness turns out to be a core element of a game within the scope of game feel and the player experience. It affects not just the fun of a game, but improves learning, makes actions feel more impactful, and is a big influence on the coherency and clarity of a game from a player's gameplay perspective. So, it is a useful term and might be considered a core element of game feel.

The combination of several different sources deepened the understanding of what juiciness is. Not only from research on game feel and juiciness, but also from a methodological, learning, and ethical perspective. The previous works do discuss their methods, and motivations, although applying the analysis method from the presence questionnaire to the entirety of the collected data and not only for its specific parts helped more than expected. The same is true for most of the sources, such as merging the design domains by Pichlmair and Johansen (2022), and the juiciness framework by Hicks et al. (2018). All of which creates a stronger foundation for further study into juiciness as this could serve as a method during juiciness research (if it designs any) to validate its designs so that the research can effectively claim their results are correct, and as an extension to this, the same for development.

Although there are discussions on the ethics of making addictive games and juiciness could feasibly contribute to it, but that would only be possible if the designer behind the game is already taking advantage of certain psychological theories in addition to juiciness. There will always be juiciness in polished games, but that does not mean polished games take advantage of their players.

6.2 Future Work

There are several directions which can be taken from here, the first one that stands out is a better look into the connection between human cognitive architecture and multimodal learning in the context of both games for entertainment and games for learning. Secondly, a literature review which looks at juiciness and cognitive theory. There have been several studies on cognitive theory on this topic that have been published very closely together which may contain information that may have been missed here due to time constraints and scope. Lastly a deeper dive into the design tasks of juiciness would be insightful for the design and analysis of juiciness.

6.3 Generative AI Disclaimer

There are no text or images within this thesis generated by any AI. All use of generative AI has purely been to expand vocabulary for better use alternative words which were used in the writing process by the author. No generative AI has generated anything critically or analytically for any of the sections within the text. The generative AI used was Copilot which is available within Microsoft Word directly, only for testing purposes to see what it could be useful for. Google was eventually preferred over Copilot in most cases because Google does not argue back or blindly support every suggestion made.

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Appendix A - The Juiciness Questionnaire – Close To Flight

Question Identification

Label	Definition
T	Tailored Question
S	Standard Question
R	Ranked answer (0 – 4, Not at all - Extremely)
W	Written answer (Optional)

Table 5: Labels for identifying how questions were answered and its origin

The Game Juiciness Questionnaire

Identification	Question	Code
TR 1	*I knew when the grapple hook attached to something*	Positive Effect, Control Factor, Direct Feedback Design
TR 2	*I knew when the grapple failed*	Positive Effect, Control Factor, Direct Feedback Design
TR 3	*I knew when the grapple didn't hit anything*	Positive Effect, Control Factor, Direct Feedback Design
TR 4	*I could tell what could be grappled and not*	Positive Effect, Sensory Factor, Game State Integration
TR 5	*I could tell how fast I was swinging*	Positive Effect, Sensory Factor, Direct Feedback Design, Game State Integration
TR 6	*I could tell how fast I was reeling up and down in the grapple*	Positive Effect, Sensory Factor, Direct Feedback Design
TR 7	*I could tell when the grapple was at maximum or minimum length*	Positive Effect, Realism Factor, Game State Integration

TR 8	*I knew what the feathers were*	Positive Effect, Sensory Factor, Realism Factor, Direct Feedback Design
TR 9	*Collecting the feathers felt important*	Positive Effect, Realism Factor, Game Characteristics Alignment
TR 10	*I understood why feathers were important*	Positive Effect, Control Factor, Realism Factor, Direct Feedback Design, Game State Integration
TR 11	*I understood when I reached a checkpoint*	Positive Effect, Realism Factor, Control Factor, Game State Integration
TR 12	*The visuals communicated the game state*	Positive Effect, Control Factor, Realism Factor, Game State Integration
TR 13	*I knew when the game state changed*	Positive Effect, Realism Factor, Control Factor, Direct Feedback Design
TR 14	*controlling the grapple mid swing was meaningful*	Positive Effect, Control Factor, Direct Feedback Design
TR 15	*I could feel the influence of my inputs on how it affected the swinging mid grapple*	Positive Effect, Realism Factor, Sensory Factor, Game Characteristics Alignment
TR 16	*I could easily distinguish important game elements from each other*	Positive Effect, Realism Factor, Game State Integration, Game Characteristics Alignment
TR 17	*The game acted as expected*	Positive Effect, Distraction Factor, Game Characteristics Alignment

TR 18	*My attention was drawn to important elements*	Negative Effect, Realism Factor, Direct Feedback Design
TR 19	*I wish the grapple hook felt better*	Negative Effect, Realism Factor, Direct Feedback Design
TR 20	*I wish movement felt better*	Negative Effect, Realism Factor, Direct Feedback Design
TW 21	*What feedback was missing?*	Negative Effect, Sensory Factor, Realism Factor
TW 22	*Which state changes were not communicated?*	Negative Effect, Control Factor, Sensory Factor
TW 23	*Which visuals felt out of place or did not fit in with the rest of the game?*	Negative Effect, Distraction Factor, Realism Factor
TW 24	*What game elements and/or visuals were contradicting each other?*	Negative Effect, Realism Factor, Distraction Factor
TW 25	*Which visual effects were more confusing than helpful?*	Negative Effect, Distraction Factor
TW 26	*Which game elements were missing to communicate what can be grappled and not?*	Negative Effect, Realism Factor, Sensory Factor
TW 27	*What was your reaction to the feather pickups?*	Sensory Factor
TW 28	*Anything else in mind that did not fit anywhere else in these questions? Positive and/or negative*	None
SR 29	*I felt skillful*	Positive Effect, Control Factor
SR 30	*I thought it was fun*	Positive Effect, Distraction Factor
SR 31	*I was fully occupied with the game*	Positive Effect, Distraction Factor
SR 32	*I thought about other things*	Negative Effect,

		Distraction Factor
SR 33	*I found it tiresome*	Negative Effect, Realism Factor
SR 34	*I felt competent*	Positive Effect, Control Factor
SR 35	*It was aesthetically pleasing*	Positive Effect, Sensory Factor
SR 36	*I forgot everything around me*	Positive Effect, Realism Factor, Distraction Factor
SR 37	*I felt good*	Positive Effect, Control Factor, Distraction Factor
SR 38	*I was good at it*	Positive Effect, Control Factor
SR 39	*I felt bored*	Negative Effect, Distraction Factor
SR 40	*I felt successful*	Positive Effect, Control Factor
SR 41	*I enjoyed it*	Positive Effect, Distraction Factor
SR 42	*I was fast at reaching the game's targets / goals*	Positive Effect, Control Factor
SR 43	*I was annoyed*	Negative Effect, Distraction Factor
SR 44	*I felt irritable*	Negative Effect, Distraction Factor
SR 45	*I lost track of time*	Positive Effect, Distraction Factor
SR 46	*I found it impressive*	Positive Effect, Realism Factor
SR 47	*I was deeply concentrated in the game*	Positive Effect, Distraction Factor
SR 48	*I felt frustrated*	Negative Effect, Distraction Factor

SR 49	*It felt like a rich experience*	Positive Effect, Sensory Factor, Control Factor
SR 50	*How much were you able to control events?*	Positive Effect, Control Factor
SR 51	*How responsive was the environment to action that you initiated?*	Positive Effect, Control Factor
SR 52	*How natural did your interactions with the environment seem?*	Positive Effect, Control Factor
SR 53	*How completely were all of your senses engaged?*	Positive Effect, Control Factor
SR 54	*How much did the visual aspects of the environment involve you?*	Positive Effect, Sensory Factor
SR 55	*How much did the auditory aspects of the environment involve you?*	Positive Effect, Sensory Factor
SR 56	*How aware were you of your display and control devices?*	Negative Effect, Sensory Factor
SR 57	*How compelling was your sense of objects moving through space?*	Positive Effect, Distraction Factor
SR 58	*How inconsistent or disconnected was the information coming from your various senses?*	Negative Effect, Sensory Factor
SR 59	*Were you able to anticipate what would happen next in response to the actions that you performed?*	Positive Effect, Realism Factor
SR 60	*How completely were you able to actively survey or search the environment using vision?*	Positive Effect, Control Factor
SR 61	*How well could you identify sounds?*	Positive Effect, Control Factor, Sensory Factor, Realism Factor
SR 62	*How well could you localize sounds?*	Positive Effect, Realism Factor, Sensory Factor
SR 63	*How compelling was your sense of moving around inside the virtual environment?*	Positive Effect, Sensory Factor
SR 64	*To what degree did you feel confused or disoriented?*	Negative Effect, Realism Factor
SR 65	*How distracting was the control mechanism?*	Negative Effect,

		Distraction Factor
SR 66	*How much delay did you experience between your actions and expected outcomes?*	Negative Effect, Control Factor
SR 67	*How quickly did you adjust to the virtual environment experience?*	Positive Effect, Control Factor
SR 68	*How proficient in moving and interacting with the virtual environment did you feel?*	Positive Effect, Control Factor
SR 69	*How much did the visual display quality interfere or distract you from performing assigned tasks or required activities?*	Negative Effect, Distraction Factor
SR 70	*How much did control devices interfere with the performance of assigned tasks or required activities?*	Negative Effect, Control Factor, Distraction Factor
SR 71	*How well could you concentrate on the assigned tasks or required activities?*	Positive Effect, Distraction Factor
SR 72	*The winning conditions were clear and presented early*	Positive Effect, Distraction Factor
SR 73	*Each sub goal to reach the win condition was clear and presented at appropriate times*	Positive Effect, Distraction Factor
SR 74	*Visual elements distracted from understanding my goals or progress*	Negative Effect, Distraction Factor
SR 75	*Visual elements supported my actions*	Positive Effect, Control Factor, Sensory Factor
SR 76	*I understood the game state*	Positive Effect, Control Factor, Realism Factor
SR 77	*Stimuli from different sources supported each other.*	Positive Effect, Realism Factor
SR 78	*The stimuli gave me important information worth focusing on*	Positive Effect, Distraction Factor
SR 79	*The stimuli grabbed my attention*	Positive Effect, Sensory Factor, Distraction Factor
SR 80	*I was focused throughout the game*	Positive Effect, Distraction Factor
SR 81	*There were tasks that felt unimportant*	Negative Effect, Realism Factor

SR 82	*I felt overwhelmed*	Negative Effect, Realism Factor
SR 83	*I felt challenged*	Positive Effect, Control Factor
SR 84	*Stimuli were distracting from the task I was trying to complete.*	Negative Effect, Distraction Factor

Table 6: The final questionnaire used in the AB testing of Close To Flight

Appendix B - Questionnaire Results

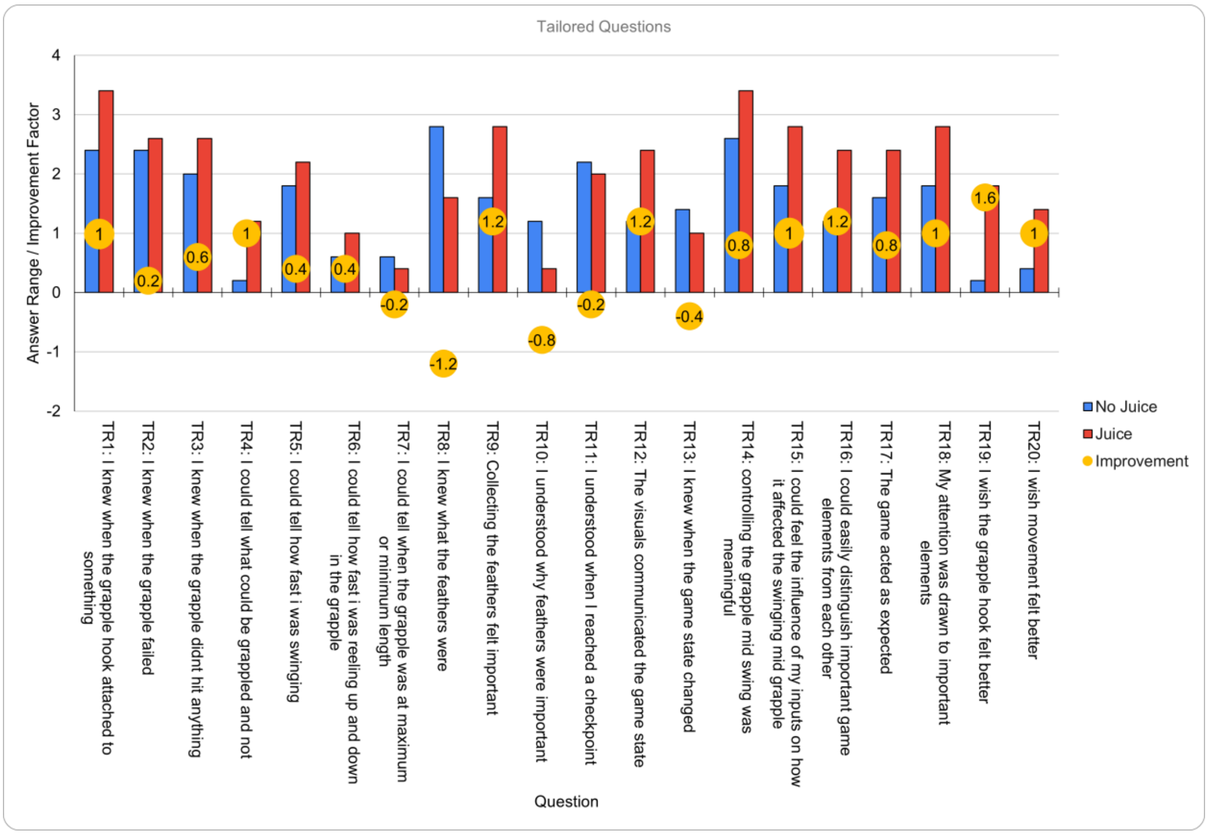

Figure 8: Close To Flight AB Test Questionnaire results, showing all the ranked tailored questions

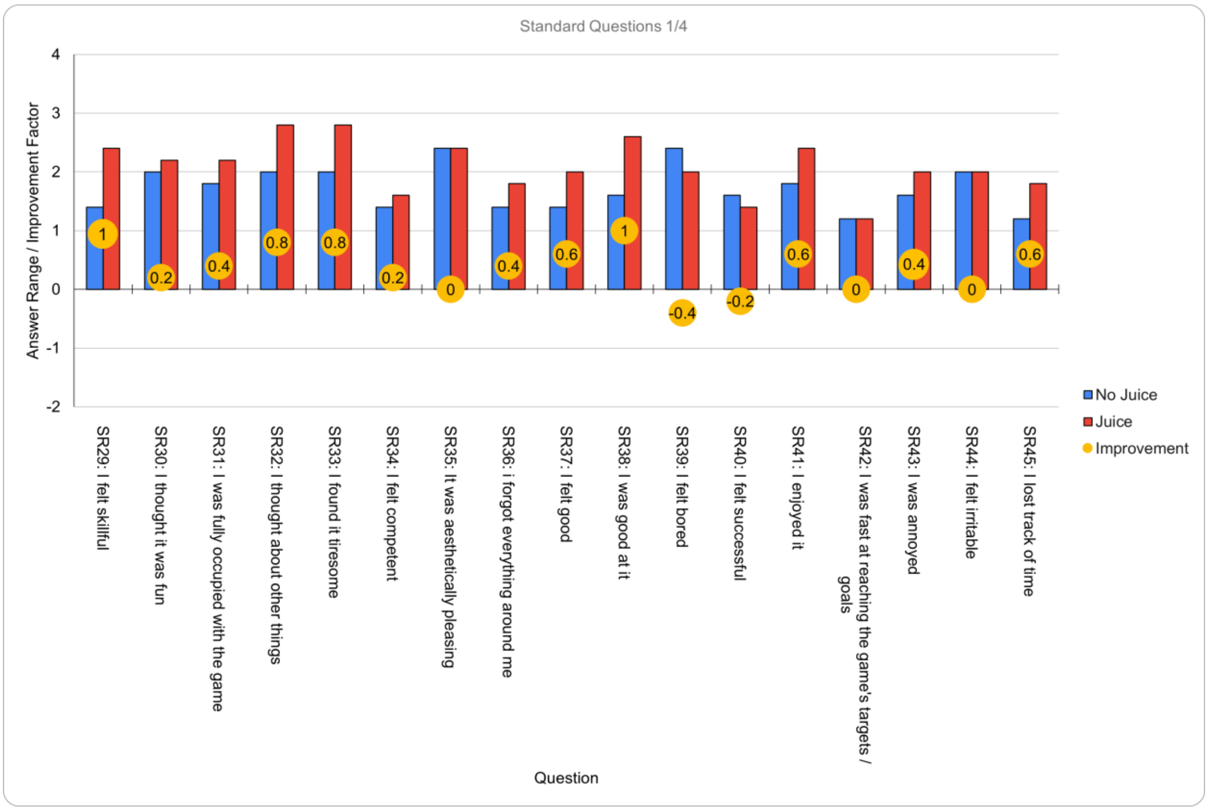

Figure 9: Close To Flight AB Test Questionnaire results, showing standard questions 1/4

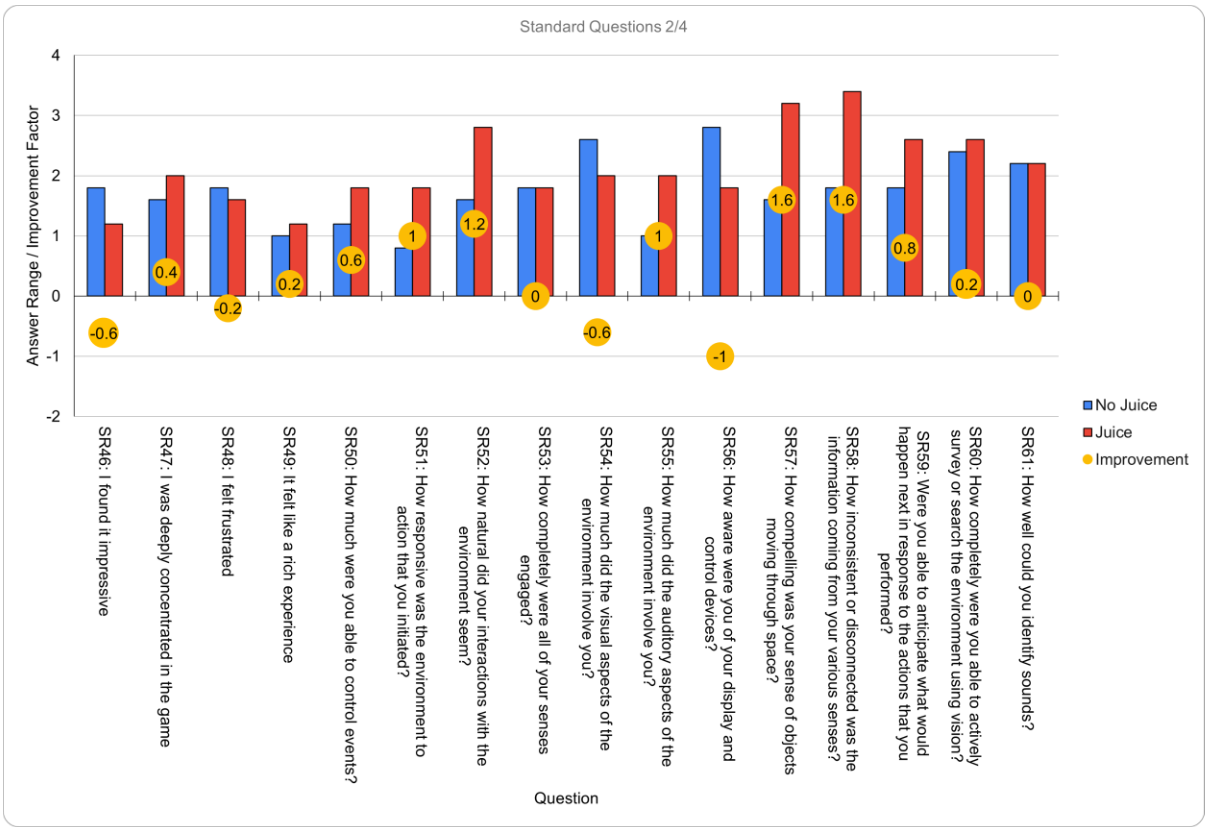

Figure 10: Close To Flight AB Test Questionnaire results, showing standard questions 2/4

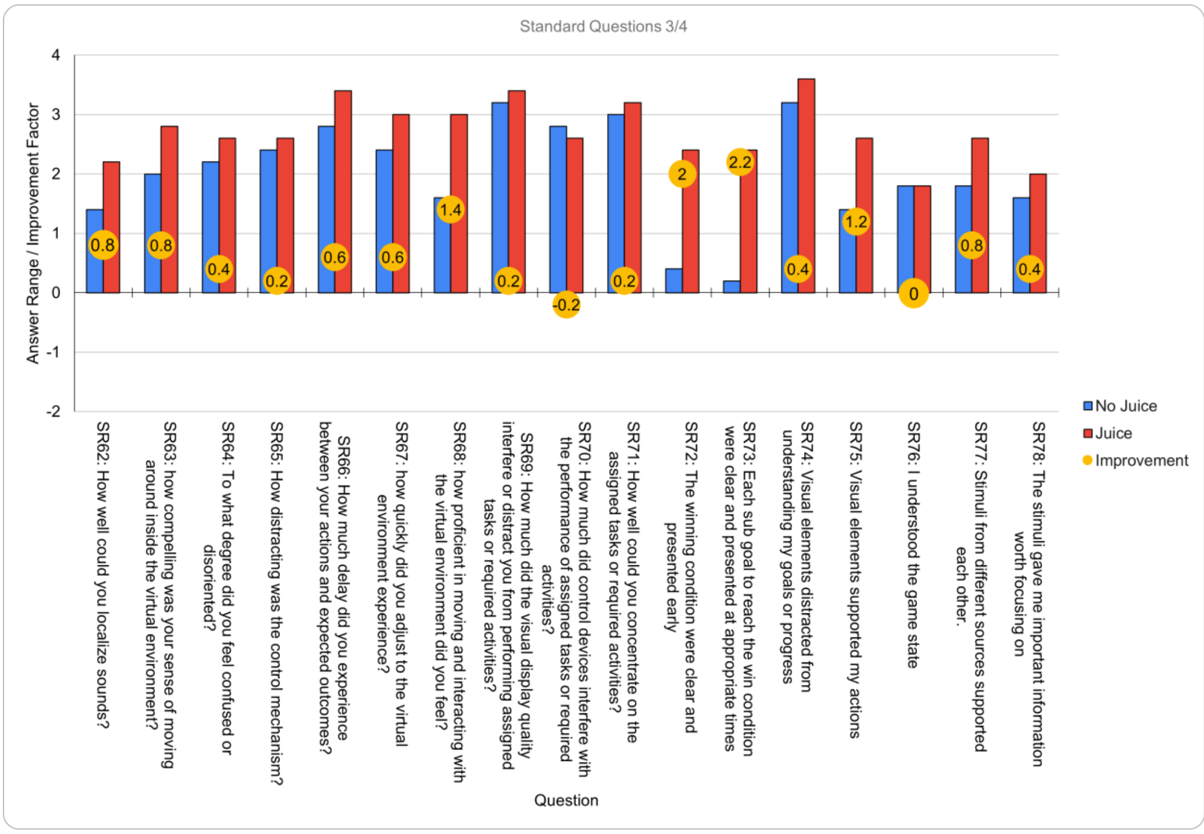

Figure 11: Close To Flight AB Test Questionnaire results, showing standard questions 3/4

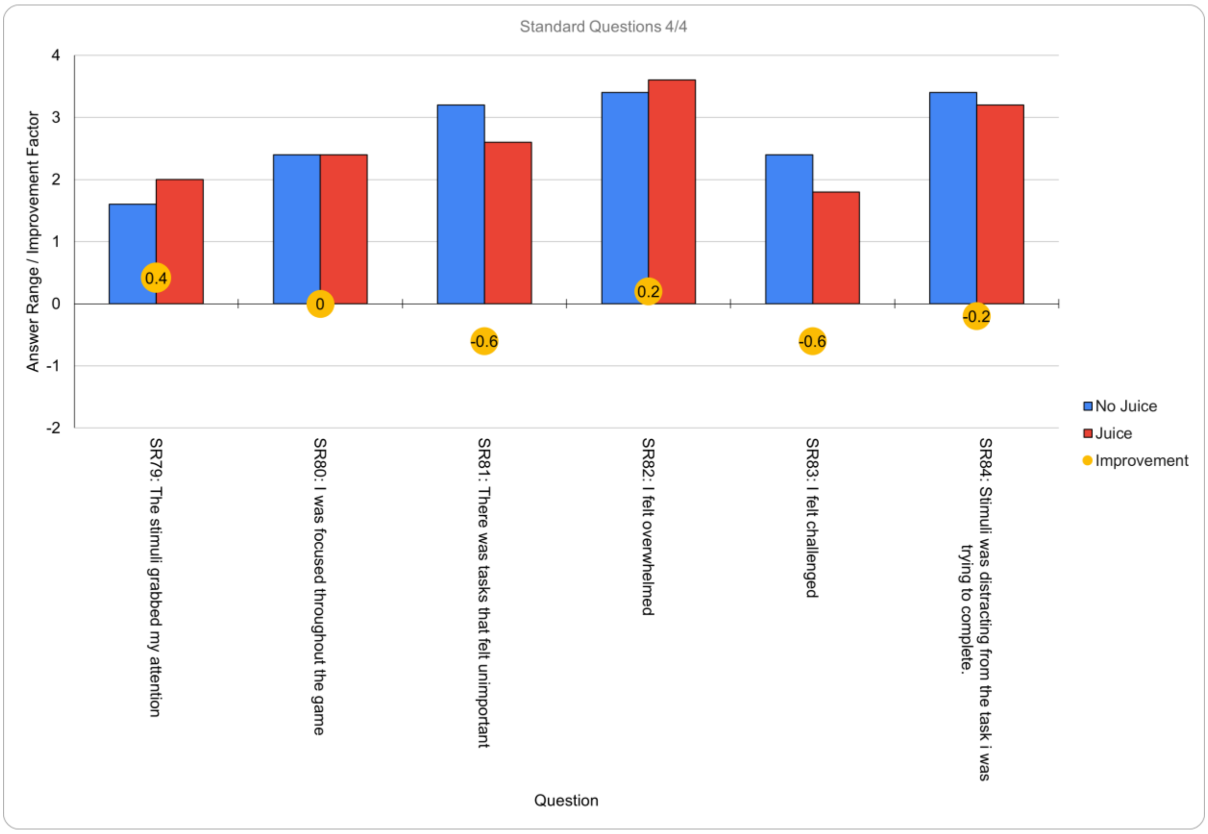

Figure 12: Close To Flight AB Test Questionnaire results, showing standard questions 4/4

Appendix C - Data Analysis Sheet

Question	Code	No Juice Score	Juiced Score	Improvement	Reversed Improvement Range
I knew when the grapple hook attached to something	Positive Effect, Control Factor, Direct Feedback Design	2.4	3.4	1	no
I knew when the grapple failed	Positive Effect, Control Factor, Direct Feedback Design	2.4	2.6	0.2	no
I knew when the grapple didn't hit anything	Positive Effect, Control Factor, Direct Feedback Design	2	2.6	0.6	no
I could tell what could be grappled and not	Positive Effect, Realism Factor, Game Characteristics Alignment, Direct Feedback Design	0.2	1.2	1	no
I could tell how fast I was swinging	Positive Effect, Sensory Factor, Game State Integration	1.8	2.2	0.4	no
I could tell how fast I was reeling up and down in the grapple	Positive Effect, Sensory Factor, Direct Feedback Design, Game State Integration	0.6	1	0.4	no
I could tell when the grapple was at maximum or minimum length	Positive Effect, Sensory Factor, Direct Feedback Design	0.6	0.4	-0.2	no
I knew what the feathers were	Positive Effect, Realism Factor, Game State Integration	2.8	1.6	-1.2	no
Collecting the feathers felt important	Positive Effect, Sensory Factor, Realism Factor, Direct Feedback Design	1.6	2.8	1.2	no
I understood why feathers were important	Positive Effect, Realism Factor, Game Characteristics Alignment	1.2	0.4	-0.8	no
I understood when I reached a checkpoint	Positive Effect, Control Factor, Realism Factor, Direct Feedback Design, Game State Integration	2.2	2	-0.2	no
The visuals communicated the game state	Positive Effect, Realism Factor, Control Factor, Game State Integration	1.2	2.4	1.2	no
I knew when the game state changed	Positive Effect, Control Factor, Realism Factor, Game State Integration	1.4	1	-0.4	no
controlling the grapple mid swing was meaningful	Positive Effect, Realism Factor, Control Factor, Direct Feedback Design	2.6	3.4	0.8	no
I could feel the influence of my inputs on how it affected the swinging mid grapple	Positive Effect, Control Factor, Direct Feedback Design	1.8	2.8	1	no
I could easily distinguish important game elements from each other	Positive Effect, Realism Factor, Sensory Factor, Game Characteristics Alignment	1.2	2.4	1.2	no
The game acted as expected	Positive Effect, Realism Factor, Game State Integration, Game Characteristics Alignment	1.6	2.4	0.8	no
My attention was drawn to important elements	Positive Effect, Distraction Factor, Game Characteristics Alignment	1.8	2.8	1	no
I wish the grapple hook felt better	Negative Effect, Realism Factor, Direct Feedback Design	0.2	1.8	1.6	yes
I wish movement felt better	Negative Effect, Realism Factor, Direct Feedback Design	0.4	1.4	1	yes
What feedback was missing?	Negative Effect, Sensory Factor, Realism Factor	written answers	written answers		
Which state changes were not communicated?	Negative Effect, Control Factor, Sensory Factor	written answers	written answers		
Which visuals felt out of place or did not fit in with the rest of the game?	Negative Effect, Distraction Factor, Realism Factor	written answers	written answers		
What game elements and/or visuals were contradicting each other?	Negative Effect, Realism Factor, Distraction Factor	written answers	written answers		
Which visual effects were more confusing than helpful?	Negative Effect, Distraction Factor	written answers	written answers		
Which game elements were missing to communicate what can be grappled and not?	Negative Effect, Realism Factor, Sensory Factor	written answers	written answers		
What was your reaction to the feather pickups?	Sensory Factor	written answers	written answers		
Anything else in mind that did not fit anywhere else in these questions? Positive and/or negative		written answers	written answers		
Standard question separator ---	------------------------------	-----------------------------	--------------------------	--------------------------	---------------------------------------
I felt skillful	Positive Effect, Control Factor	1.4	2.4	1	no

I thought it was fun	Positive Effect, Distraction Factor	2	2.2	0.2	no
I was fully occupied with the game	Positive Effect, Distraction Factor	1.8	2.2	0.4	no
I thought about other things	Negative Effect, Distraction Factor	2	2.8	0.8	yes
I found it tiresome	Negative Effect, Realism Factor	2	2.8	0.8	yes
I felt competent	Positive Effect, Control Factor	1.4	1.6	0.2	no
It was aesthetically pleasing	Positive Effect, Sensory Fctor	2.4	2.4	0	no
I forgot everything around me	Positive Effect, Realism Factor, Distraction Factor	1.4	1.8	0.4	no
I felt good	Positive Effect, Control Factor, Distraction Factor	1.4	2	0.6	no
I was good at it	Positive Effect, Control Factor	1.6	2.6	1	no
I felt bored	Negative Effect, Distraction Factor	2.4	2	-0.4	yes
I felt successful	Positive Effect, Control Factor	1.6	1.4	-0.2	no
I enjoyed it	Positive Effect, Distraction Factor	1.8	2.4	0.6	no
I was fast at reaching the game's targets / goals	Positive Effect, Control Factor	1.2	1.2	0	no
I was annoyed	Negative Effect, Distraction Factor	1.6	2	0.4	yes
I felt irritable	Negative Effect, Distraction Factor	2	2	0	yes
I lost track of time	Positive Effect, Distraction Factor	1.2	1.8	0.6	no
I found it impressive	Positive Effect, Realism Factor	1.8	1.2	-0.6	no
I was deeply concentrated in the game	Positive Effect, Distraction Factor	1.6	2	0.4	no
I felt frustrated	Negative Effect, Distraction Factor	1.8	1.6	-0.2	yes
It felt like a rich experience	Positive Effect, Sensory Factor, Control Factor	1	1.2	0.2	no
How much were you able to control events?	Positive Effect, Control Factor	1.2	1.8	0.6	no
How responsive was the environment to action that you initiated?	Positive Effect, Control Factor	0.8	1.8	1	no
How natural did your interactions with the environment seem?	Positive Effect, Control Factor	1.6	2.8	1.2	no
How completely were all of your senses engaged?	Positive Effect, Control Factor	1.8	1.8	0	no
How much did the visual aspects of the environment involve you?	Positive Effect, Sensory Factor	2.6	2	-0.6	no
How much did the auditory aspects of the environment involve you?	Positive Effect, Sensory Factor	1	2	1	no
How aware were you of your display and control devices?	Negative Effect, Sensory Factor	2.8	1.8	-1	yes
How compelling was your sense of objects moving through space?	Positive Effect, Distraction Factor	1.6	3.2	1.6	no
How inconsistent or disconnected was the information coming from your various senses?	Negative Effect, Sensory Factor	1.8	3.4	1.6	yes
Were you able to anticipate what would happen next in response to the actions that you performed?	Positive Effect, Realism Factor	1.8	2.6	0.8	no
How completely were you able to actively survey or search the environment using vision?	Positive Effect, Control Factor	2.4	2.6	0.2	no
How well could you identify sounds?	Positive Effect, Control Factor, Sensory Factor, Realism Factor	2.2	2.2	0	no
How well could you localize sounds?	Positive Effect, Realism Factor, Sensory Factor	1.4	2.2	0.8	no
How compelling was your sense of moving around inside the virtual environment?	Positive Effect, Sensory Factor	2	2.8	0.8	no
To what degree did you feel confused or disoriented?	Negative Effect, Realism Factor	2.2	2.6	0.4	yes
How distracting was the control mechanism?	Negative Effect, Distraction Factor	2.4	2.6	0.2	yes
How much delay did you experience between your actions and expected outcomes?	Negative Effect, Control Factor	2.8	3.4	0.6	yes
How quickly did you adjust to the virtual environment experience?	Positive Effect, Control Factor	2.4	3	0.6	no
How proficient in moving and interacting with the virtual environment did you feel?	Positive Effect, Control Factor	1.6	3	1.4	no
How much did the visual display quality interfere or distract you from performing assigned tasks or required activities?	Negative Effect, Distraction Factor	3.2	3.4	0.2	yes
How much did control devices interfere with the performance of assigned tasks or required activities?	Negative Effect, Control Factor, Distraction Factor	2.8	2.6	-0.2	yes
How well could you concentrate on the assigned tasks or required activities?	Positive Effect, Distraction Factor	3	3.2	0.2	no
The winning condition were clear and presented early	Positive Effect, Distraction Factor	0.4	2.4	2	no
Each sub goal to reach the win condition was clear and presented at appropriate times	Positive Effect, Distraction Factor	0.2	2.4	2.2	no

Visual elements distracted from understanding my goals or progress	Negative Effect, Distraction Factor	3.2	3.6	0.4	yes
Visual elements supported my actions	Positive Effect, Control Factor, Sensory Factor	1.4	2.6	1.2	no
I understood the game state	Positive Effect, Control Factor, Realism Factor	1.8	1.8	0	no
Stimuli from different sources supported each other.	Positive Effect, Realism Factor	1.8	2.6	0.8	no
The stimuli gave me important information worth focusing on	Positive Effect, Distraction Factor	1.6	2	0.4	no
The stimuli grabbed my attention	Positive Effect, Sensory Factor, Distraction Factor	1.6	2	0.4	no
I was focused throughout the game	Positive Effect, Distraction Factor	2.4	2.4	0	no
There were tasks that felt unimportant	Negative Effect, Realism Factor	3.2	2.6	-0.6	yes
I felt overwhelmed	Negative Effect, Realism Factor	3.4	3.6	0.2	yes
I felt challenged	Positive Effect, Control Factor	2.4	1.8	-0.6	no
Stimuli were distracting from the task I was trying to complete.	Negative Effect, Distraction Factor	3.4	3.2	-0.2	yes

Table 6: all raw averaged data extracted from the questionnaires, together with the improvement factor.

Appendix D - JUICYDEMO Readme Section

Everything under this section is copied from a section of the readme from the demo repository (Løkken, 2023).

Levels of juice

The effects added are not in a prioritized order, rather in the order it would seem most incremental in the demonstration.

1. Cool gun. The game is about shooting, so the thing that shoots has to be interesting. In this game it was hard for me to make the *player* interesting, but we could spice up the gun a little.

2. More shooting. Again, this game is about shooting, so it always good to try to add more of the core mechanic. Sometimes less is more, but you never know until you know what "more" is.

3. Visualization. Not really juice, but it is very important to somehow visualize to the player what's going on. Give the players a way to understand the game so they can take informed decisions, rather than speculate and rely on assumptions.

4. Sound effects. The most powerful and most bang-for-the-bucks juice ever. For the programmer at least. They can be hard to make, but even placeholder SFX lifts a game prototype up high.

5. Particles. Mother of Juice. Particles are (after sound) the easiest way to tell the player that something just happened. This is critical feedback. Every interaction should spawn particles. They also have the benefit that they work for deaf players and those who play without sound.

6. Animations. This is harder to generalize, but animating everything you can in some way makes the game feels super juicy. With just a wobble that is very simple for programmers to implement you add no artist workload, but add tons to the game.

7. Screenshake. The simplest, and both overused and underutilized. I went a bit crazy here, but adding small shake effects on every impact is great. For actual games it is good to let the player scale back the effect (all the way to zero), because it can make some people motion sick.

8. Colors. This can be a hard one, but finding a simple color palette to use instead of using just "programmer-default colors" (such as #FF0000 or #FF00FF) makes a big difference. In many cases, especially in 3D it is infinitely better than just using white textures as well.

9. Music. This can be as simple or complex as you like. Dynamic phasing in and out layers of sound based on the context is amazing, and never-repeating patterns, smooth fading between tracks without breaking rhythm is super cool. But simple loops works great as well, especially for a prototype.

10. MORE PARTICLES. Go hard or go home. Just because we have used one trick once does not mean it is spent.

11. UI animation. In order to bring the players attention to changes in the UI, such as score increase, damage takes, etc, it works wonders to flash, shake, bounce, or in some other way animate the UI.

12. CRAZY. I added this layer just for fun, to take it over the top. The flashing background is probably not a good idea, theres (if possible) too many particles, and the enemies spawn faster. You can have too much of a good thing, but it is valuable to go there and then scale back, so you can find the correct balance for your game.

1. **Some effects I didn't show in the demo but are super important**

2. Tweening. Often in games we move stuff. It can be handy to use code such as lerp(start, end, t), where t increases some amount every frame and goes between 0 and 1. But this moves stuff at a constant speed, meaning there's is a jerk at the start, and a hard collision at the end. Instead, use an easing library, or wrap t in an easing function such as function ease(t) { return 3*t*t-2*t*t*t; } which will give you a smooth start and stop. There's many such functions out there, and everyone uses them. Another trick is to move towards your target by moving a percentage of the way every frame, like x = x + (target - x) * 0.1. This gives you a slowdown as you approach the target which can look nice. This is not only for positions, but can and should also be used for scale, rotation, and sometimes color.

3. Squash and stretch. This is something the animators are good at, but often is easy for the programmer to do as well, and can be made so that the animators don't have to redraw as many animations if the concept of a character changes. Use some kind of easing function and increase scale in the direction something travels, and decrease scale in the perpendicular direction. In 3D you have two perpendicular directions that can be hard to find. In that case, just stretching in the direction of travel can be good enough.

(Løkken, 2023)

Appendix E - JUICYDEMO VFX Showcase

This GitHub repository contains videos that showcases the VFX that is present in the JUICYDEMO which was used for the AB test during the pilot study where the player played both versions and answered the questionnaire twice, once for each version. These videos are not from any play testers, these were captured for the purpose of showing the differences between no juice, and all the juice.

Note: GitHub does not support viewing large video files on site. Download the files to view them. Either by clicking the green "<> Code" button and then download zip, or go to the specific file and press the three dots "..." and download, or press the blue "view raw" link which will prompt a download of the file.

https://github.com/HenrysHouses/JUICYDEMO-VFX-Showcase

Appendix F - Created VFX Showcase

This GitHub repository contains videos that showcases the VFX that was created for Northrak during the study. The demos that were played by the testers had either none or all of these additional visuals implemented. Note that the saving icon when a collectible is picked up was not made by me but rather was already implemented and is present in both versions. Showing there is a saving icon during the feedback is important for the data to understand why some players were confused.

Note: GitHub does not support viewing large video files on site. Download the files to view them. Either by clicking the green “<> Code” button and then download zip, or go to the specific file and press the three dots “...” and download, or press the blue “view raw” link which will prompt a download of the file.

https://github.com/HenrysHouses/CloseToFlight-VFX-Showcase