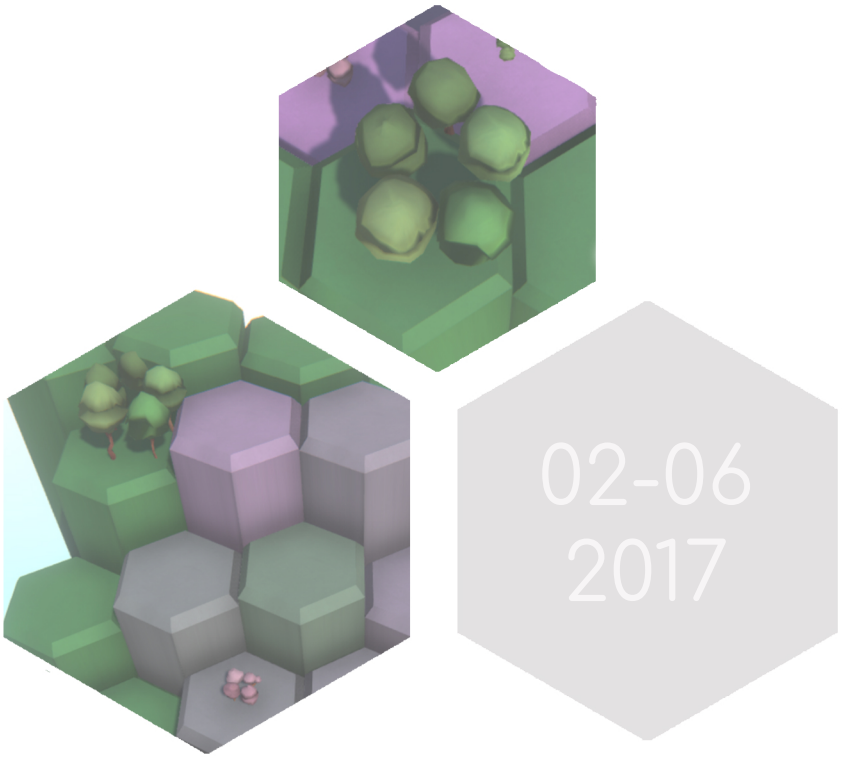
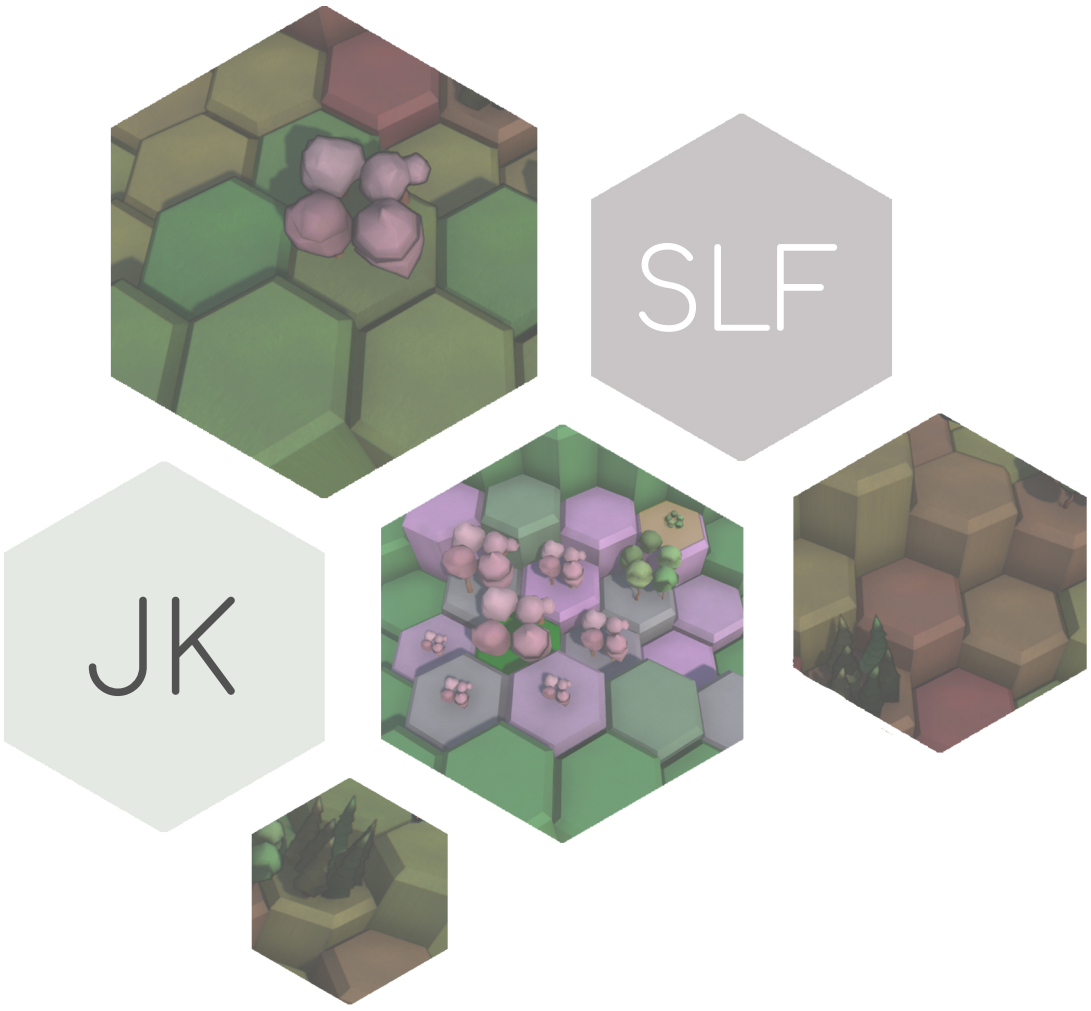


Master's thesis

Juiciness - A Study of Visual Effects in Games

By Jiri Korniek & Sandra Louise Fagerli



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Abstract:

Continuation desire has been an intensely researched topic. Scholars such as Schønau-Fog mention sensory engagement (Engagement caused by audio, visuals, aesthetics and atmosphere.) as an important component that plays part in the process that influences players to continue playing video games.
Interestingly enough there is an overlap between sensory engagement and a video-game related term - Juiciness. Certain elements found in the sensory engagement category can be considered juicy, for example animations, particle effects, lighting, etc. Although this category is considered important, not much research has been on the individual elements.

This is where this research steps in. The definition of juiciness effects will be established and selected effects will be tested against each other to see whether there is or is not a significant difference between them. Based on research, these effects will be tested inside of a puzzle game environment developed across three iterations. The effects are animations, particles and lights.
A total of 182 players were a part of the three tests - a usability test and two research tests.

Although not statistically significant, the results point in the direction that out of all tested effects, particles have the strongest positive impact on continuation desire.

Contents

1

Introduction

Continuation desire has been an intensely researched topic. When looking at continuation desire we can see scholars such as Schønau-Fog (2011) mentioning sensory engagement as one of the important categories that influence continuation desire. What is sensory engagement? Research describes it as engagement caused by audio, visuals, aesthetics and atmosphere. Interestingly enough this has a good overlap with another term surrounding video game effects - Juiciness. The sensory category is the one that can contain the elements that can be considered juicy - animations, lights, particles, etc.. Although the importance of this category is mentioned not enough research has been done on the individual elements.

Since this seems like an interesting issue, a research will be conducted, trying to understand better the relation between continuation desire and the individual sensory category elements - from now on called juiciness effects.

Testing isolated individual elements with existing games might prove very difficult since not all games are open to modification. In this case the suitable course of action is developing a custom made game as the media-technological product, where there is complete control over what kind of elements are presents, where they are present and how they are made.

When talking about juiciness in games, it would be advisable to focus on games that utilize it well to their advantage when motivating people to continue, such as Candy Crush Saga (Gregory S. Anderson et al., 2015). With research done on puzzle games and scholars saying that visual effects are an important layer to keep players interested (Malone, 1980) in these puzzle games, picking puzzle as the genre for the developed game becomes a very sensible choice.

In the following chapters we are going going to attempt to answer the question whether there is a difference between these different juiciness effects when it comes to impacting continuation.

2

Research

In this chapter, relevant research from the fields of continuation desire and juiciness/juiciness elements is going to be analyzed. The objective of this is to gain an understanding of the possible overlap and relationship between these topics and eventually lead up to creating design requirements for the experiment and the product as well as setting up hypotheses for the research question.

2.1 Juiciness and Game Elements

Right from the start it is necessary to establish what juiciness is and how does it affect players in video games. In the paper *Good Feedback for bad Players? A preliminary Study of 'juicy' Interface feedback* Juul and Begy (2016) have developed a preliminary empirical study on juiciness effects and game feel. They define juiciness as a positive visual feedback occurring in a video game. They discuss whether juiciness is contributing to better game experience, which makes the game more alive, and how the players' performance is - in a more 'juiced' game. In their study they developed a game with two versions, one with core game mechanics and another one with juiciness effects and extra unnecessary feedback for the players' actions in the game. Some of these effects were particles and supplementary sound effects. Their experiment tested 46 test participants. They define juiciness as only positive visual feedback, but it can be argued that juiciness effects can also contain negative visual feedback, for example if someone shoots you in a video game the screen is blinking red. A criticism of their study could be the fact that some of their effects were redundant (Kalyuga et al., 1999), not conveying any specific information to the player. Also, the quality of the implemented effects has not been taken into consideration which could potentially become a biasing element in the research.

Inspiration has been taken from their research - it could be interesting to research whether some juiciness effects have different impact on the game and game mechanics than other juiciness effects.

In the master thesis *Exploring and designing around experience of feed-*

back in video games Atanasov (2013) tries to convey experience in video games and the juiciness and feedback which games provide. Atanasov focuses on experience design and juiciness effects regarding aesthetic and visual feedback. The paper goes more into visceral design and behavioral and reflective design by Norman and Ortony (2003), which are categorized as different emotional responses. Atanasov defines juiciness as specific aesthetic feedback traits in video games. The thesis concludes that an unified description of juiciness is non existing. He claims that every player has a different way on defining what the term juiciness means, because it is based on interpreted experience. The paper is very focused on aesthetics in juiciness, however it is also possible to look at it more game mechanics wise. His findings can be used in this project as they claim that the effects need to be aesthetically pleasing and well made.

In the master thesis report: *Juiciness in Citizen Science Computer Games: Analysis of a Prototypical Game* (Buckthal, 2014) juiciness is being tested in a Citizen Science computer game, where Buckthal creates an experiment in a science game where both a juiced version and a non juiced version is being tested and evaluated upon. The report tested if juiciness in games increased the understanding of the game mechanics and the game concepts. Furthermore it tests to see if juiciness improves the enjoyability. The report discusses whether juiciness can improve player motivation and various terms like visceral design, game feel and aesthetics, where it concludes that game feel consists of: the player control, the game world and the polish of the game.

The report states that feedback in the game is very important due to the player being able to perceive how to navigate in the game and how to play the game. Where good juiciness effects makes the player feel in control and if developed properly can guide the player as well. However it seemed that in their experiment the juiciness effects were overdone, which is apparent in their result where many preferred to play the version without the effects, rather than the juiced version. Eric Buckthal also clarifies that their game had many flaws. It was discussed that the way the game mechanics was introduced were not optimal and they should have focused on presenting the game mechanics and not the science behind the game, which should have been their focus when developing a game where they test juiciness effects. In their discussion they also discuss that sound has a major role as a juiciness effects.

Based on their research their method and conclusion seems well thought out and the report goes into detail with different juiciness elements like: Sound effects, animations, and particles.

The takeaway from this is that we should look at the different juiciness elements like sound effect, animations, particles and other effects. Further-

more it is very important that we present the game mechanics to the player.

2.2 Puzzle Games

When talking about juiciness in games, it would be advisable to focus on games that utilize it well to their advantage when motivating people to continue. One of the phenomenons of this is the state-of-the-art game Candy Crush Saga (Gregory S. Anderson et al. (2015)), which uses (visual) feedback as one of the major driving forces that keep the player investing time into it. (Figure 2.1).

Figure 2.1: Screenshot from Candy Crush Saga

Candy Crush, in its bare bones form, is a mathematical puzzle (Walsh (2016)) which might seem like a bland genre to some (old numbers games like Sudoku do not exactly scream "exciting visual feedback"), but Walsh (2016) states that the mathematical intricacy is one of the things that forces people to keep playing and be interested in the game. In general, a fair amount of research has been done on different aspects of puzzle games and also other scholars such as Malone (1980) agree that visual feedback is an important layer on top of the core game mechanics if increased time investment from the

player is the objective. Furthermore, Wei et al. (2015) indirectly supports this statement by claiming that time sacrifice is one of the three major factors that make people abandon games - implying that the perception of time usage needs to be positively overpowered.

These statements make it evident that while people generally enjoy maths puzzles, it is the immediate feedback and visuals that feel rewarding and make them want to continue playing the game. The main focus of this research will therefore be the juiciness layer in regards to an inherent numbers problem, with game mechanics being taught across multiple levels as advised by Linehan et al. (2014).

2.3 Continuation Desire

Our focus in this study lies within the methodology and experimental area of continuation desire which is the determination to continue playing a game. The continuation desire methodology is developed by Henrik Schønau Fog. Schønau-Fog (2011)

The methodology is build upon investigating the engagement, flow, motivation and fun components. Prior research describes engagement as the activity that players dedicate themselves to - to complete objectives. The paper *Sure, I would like to continue* by Schønau-Fog and Bjørner (2012) supports this research by organzing the player engagement and the desire to continues into six engagement terms. These terms include the intellectual, physical, sensory, social, narrative, and emotional categories.

The third paper centered around the continuation desire topic is *Hooked! - Evaluation engagement as continuation desire in Interactive Narratives* by Schønau-Fog (2012), where the Game Experience Questionnaire (GEQ) is being discussed. The GEQ investigates player experience through seven categories which are flow, imaginative immersion, tension, competence, negative affect, positive affect and challenge. However it does not cover the effect whether a player wants to continue the experience or continue playing.

Schønau-Fog claims that the gaming industry started to pause the game and ask questions while the player is playing. This questioning method are called Tracking Real-Time User Experience (TRUE). Some of the methods TRUE uses have been in-game surveys, which extract the data directly when the player plays, but also pop- up questions while playing the game. Furthermore TRUE methods also include automated data collection while the player is playing the game. However these methods does not check

whether the player wants to continue playing even though it asks whether the player feels bored.

Regarding the research paper *Hooked! - Evaluation engagement as Continuation desire* (Schønau-Fog, 2012) it develops a methodology and an engagement sample questionnaire. It is interesting to look at this method and questionnaire in order to evaluate continuation desire while playing a game with different game elements and juiciness effects. Furthermore it could be interesting to store values while the player plays too see if there is any correlation with continuation desire, and how well the player is performing in the game. For example it could be represented by a score system, where we measure how well is the individual player performing and if this performance has any influence on his continuation desire.

Another way to conduct an experiment with continuation desire could also be to interview the players about their experiences and motivations after each completed level and whether they would like to continues the experience.

It could also be interesting to investigate the continuation desire method with the player engagement process and a questionnaire where the questions are divided into these following areas: **Objectives** - which can be set up from the experience or the user. **Activities** - which the player performs in order to accomplish the objectives. **Accomplishments** - of an objective, to complete it. **Affect and effect** - the experience while the players perform an activity or accomplish an objective. Schønau-Fog (2012)

First part consist questions about demographics, the second part asks about the premotivation to start the application and their objectives. It is possible to stop the players during the experience and ask if they want to continue by using a seven-point Likert scale and open ended questions about the experience. The last questions should be about whether the player want to play the game again and their reflections on the objectives plus the positives and negatives of continuing. It could be interesting to develop our test using the engagement sample questionnaire. The full questionnaire can be seen in Figure 2.2.

2.4 Flow

In relation to continuation desire and as stated above continuation desire is derived from Flow theory. Flow theory has been developed by Csikszentmihalyi (1990). He has researched enjoyment and what makes an activity or an experience enjoyable. His research spans over thousands of respondents

Table 1. The Engagement Sample Questionnaire

ESQ Part One: Demographics (gender, age, frequency and amount of playing, favourite game / genre)							
ESQ Part Two: Before the experience							
Q1. Please indicate below the extent to which you agree or disagree with this sentence: "I want to begin the experience" (to quantify the users Continuation Desire (CD))							
Disagree strongly	Disagree moderately	Disagree a little	Neither agree nor disagree	Agree a little	Agree moderately	Agree strongly	Other
Q2. "What makes you want/not want to begin?" (to identify the user's CD and objective)							
ESQ Part Tree: During the experience							
Q3. Please write the code which is written on the screen in the application: (identifying the latest event)							
Q4. Please indicate the extent to which you agree or disagree with this sentence: "I want to continue the experience now!" (Response options as in Q1)							
Q4. "What makes you want/not want to continue?" (to identify the source of the user's CD and objective)							
Q5. "What do you feel now?" (to indicate the user's affect)							
Q6. "What is happening in the experience?" (to explore the narrative generated by the user)							
Q7. "What do you want to do next?" (to identify the user's activity)							
Q8. "General comments concerning the experience so far" (technical, content)							
Q9. "Do you want to continue?" (yes/no) ("yes" resumes, "no" directs to the final part of the ESQ)							
ESQ Part Four: After the experience							
Q10. Please write the code which is written on the screen in the application: (identifying the latest event)							
Q11. Please indicate the extent to which you agree or disagree with this sentence: "I want to try again!" (Response options as in Q1)							
Q12, "What makes you want/not want to try again (in the application / experience)?"							
Q13. "What do you feel now?" (to indicate the user's affect)							
Q14. "What did you just experience?" (to explore the narrative generated by the user)							
Q15. "Why do you want/not want to try again?"							
Q16. "General comments concerning the experience" (technical, content)							
Q17. "How many minutes do you think you have spent in the experience?"							
Q18. Extra questions related to communication of the theme and learning outcomes, not used in this study							

Figure 2.2: The Engagement Sample Questionnaire

with interviews, questions and different data collection collected through many years of research. His studies discovered how the optimal experience i.e. "flow" was the same around the world, even when it was very different activities and experienced which also do not give any money or status as rock climbing or composing. He said that:

> "*Flow is an experience so gratifying that people are willing to do it for its own sake*" - Csikszentmihalyi (1990)"

Parts of this research - particularly the section about time perception distortion overlap with other scholars mentioned before (Wei et al., 2015) in the sense that time perception is an indicator of flow and therefore by extension an indicator of continuation desire.

2.5 Gameflow

Sweetser and Wyeth (2005) argue in *GameFlow: A Model for Evaluation Player Enjoyment in Games* that *"player enjoyment is the single most im-*

portant goal for computer games."

Sweetser and Wyeth (2005) argue that even though many enjoy different game genres and some prefer some genres over others, enjoyment and flow theory is based upon the premise that the elements of enjoyment are universal and do not differ across genres of games. Sweetser and Wyeth have developed a flow theory which in general includes the elements which are common with everyone who is experiencing enjoyment. Their research aim is to develop a game enjoyment method which is based on flow. They took different elements from flow research as e.g. concentration - a task that can be completed, a clear sense of goal and changed them to a GameFlow method. Their eight elements are as follows:

- **The Game** - a task that can be completed
- **Concentration** - Ability to concentrate on the task
- **Challenge Player Skills** - Game should match the players skills level
- **Control** - Allowed to exercise a sense of control over actions
- **Clear Goals** - The task should have clear goals
- **Feedback** - The task provides immediate feedback
- **Immersion** - Effortless involvement, reduced concern for self and sense of time
- **Social Interaction** - N/A

All these elements are very important in relation to GameFlow, however in our case it might be interesting to be selective and choose some of the variables and add them to our game design when testing the different game elements and juiciness effects.

2.6 Game Feel

In the book *Game Feel - A Game Designers Guide to Virtual Sensation*, Swink (2009) describes game feel as the experience you have when you play a game, in the context of how you feel and the experience you have when playing the game. In relation to both flow, GameFlow and continuation desire Swink also works with player experience. However, it seems that his approach is more about the aesthetic game feel, as he describes it as the space and atmosphere between the player and the controller.

> *"It will just seem right. In this sense, game feel is an "invisible art, " like cinematography. Feel is the most overlooked aspect of game creation; a powerful, gripping, tactile sensation that exists somewhere in the space between player and game. It is a kind of "virtual sensation, " a blending of the visual, aural and tactile. In short, it is one of the most powerful properties of human-computer interaction. "* - Swink (2009)

Furthermore Swink argues that game feel is really hard to understand because it is an invisible feel in a complex medium like a game, which consists of art, music, animation and story.

It seems that in his book Swink gets close to some of the terms we are using when discussing juiciness effects. However he does not discuss juiciness effects at all and he looks at the different elements as a whole package in a game, whereas it could be interesting to see whether some elements might have different impacts on continuation desire.

2.7 Juiciness Effects

Juiciness effects, are elements which are used for making a game more responsive and alive. The idea about juiciness was born from the teachers Martin Jonasson & Petri Purho who saw that their students did not add any juiciness effects and therefore the students' game seemed dull and not engaging, according to Atanasov (2013). Later at GDC - *Juice it or lose it - a talk by Martin Jonasson and Petri Purho* (2012) was presented based on their experiences. Through above research we have taken some juiciness effects which we will go more in depth too and these will be the variables we want to experiment with in our project.

2.7.1 Animation

Game Feel by Swink (2009) suggest that animation is very important, furthermore it is an important polish effect when making a video game. Swink further elaborates that an important polish effects in animation is squash and stretch when a character moves. Swink elaborates that the squash and stretch effects are very important and some games will feel very dull if you remove this effect. Atanasov (2013) also argues that animation gives life to different characters and to the experience.

Ernest Adams in *Fundamentals of Game Design* (Adams, 2009) further claims that game developers and films strive to create realistic game worlds

which include animation, photography etc.. Aesthetics is very important, where clumsy and bad animations, muddy soundtrack and sloppy artwork can ruin the game even if the game mechanics are good.

It might be a good idea to create animations which seems somewhat realistic in our game world and furthermore be aware that the animations has to be smooth and natural.

> *"The timed nature of animation, particle emission and particle life, sound duration, etc., can be attributed to a timed experience, hence satisfying properties like "continuity", "balance", "repeatability" and "emergence".* - Atanasov (2013)

It might be interesting to look at some of *The 12 principle of animation as illustrated through Disney* (2016). Some of these principles as squash and stretch, anticipation, slow in and slow out and exaggeration might be very interesting to look further into when developing animation as a juiciness effect. To go more in depth with these animations further explanation is derived from the art of computer animation and effects by Kerlow (2004).

Squash and stretch: When a body is being hit with an item it is possible to exaggerate the mesh/body and deform it so the hit squashes and stretches. The reason too add this stretch and squash is to create a dynamic or a comic effect.

Anticipation: When a cartoon figure starts to run or jump, the character often put the leg behind or crunch down to make the move. Anticipation is often created in the animation as some kind of move before the actual action starts. The anticipation helps the audience in predicting the character's next move.

Slow in and slow out: The animation is slower at the beginning and at the end of the animation. This technique is good to create anticipation in the beginning of the action and a follow through at the end of the action.

Exaggeration: Exaggeration is when you take the animation to an extreme state. Where it often is to magnify the action, it can also help increase the intensity of a given moment and prove a given point.

2.7.2 Particles

Particles are defined in *The Art of 3D: Computer Animation and Effects* (Kerlow, 2004) as many small particles which can be rendered into dust, fire, smoke, liquids etc. Furthermore *Digital Visual Effects in Cinema: The Seduction of Reality* (Prince, 2011) further condenses it to a point in 3D space that can be emulated to rotate, increase in size and color. Therefore

particles can be used in many different ways and can have various effects depending on how they are used. Koskela (2015) further elaborates that particles can have various interesting responses to actions in games. Furthermore it is possible to add smoke if something disappears, rain particles when weather changes or fireworks particles when a level is completed.

> *Smaller particles can be used for less significant events and completing levels can be rewarded with full-screen particle showers and other effects.* - Koskela (2015)

Potentially particles could be very interesting for our project. There is various ways we can use the particle system in Unity, which will be the game engine we will develop the game in. *Unity3D* (2015)

2.7.3 Visual effects

Visual effects could be very interesting to look at, Schønau-Fog (2011) says that an important category of games is sensing and he states that:

> *The category of sensory engagement makes players want to continue to play because they want to experience the audio (sounds, soundscapes and music), visuals (graphics and animated elements) and aesthetics as well as the atmosphere.* - Schønau-Fog (2011)

It can be argued that animation is it's own game element and graphics, atmosphere and lighting is another. Birn (2013) further argues that aesthetic visual lighting, and the various colors can create different atmosphere and ambience.

Koskela (2015) also discuss that color can be used to distinguish elements in the user interface or in the graphics elements in the game.

Purho and Petri also argues that screenshake is really good and it creates a great impact in the game, if it is used accordingly for example when the player is taking damage, the player will feel the burden and the physical realism. (*Juice it or lose it - a talk by Martin Jonasson and Petri Purho*, 2012)

2.7.4 Sound Effects

Through out the research more scholars have concluded that sound effects are important as a game effects, therefore it might be important to add some sound effects, however since we are not sound and music students we will try to keep this element to a minimum. Adams (2009)

2.7.5 What Is a Juiciness Effect

At this point we have gone through relevant research about juiciness and continuation desire as well as presented examples from other scholars on different types of visual elements. With this knowledge it is desirable to establish what a "juiciness effect" is in the context of this research.

A juiciness effect therefore is a complementary visual effect allowing for an aesthetic way of providing feedback to the player.

2.8 Hypotheses

Throughout the research chapter we have found effects in the visual domain that can both be connected to juiciness and continuation desire. The main hypothesis based on this is that similar to different categories of player engagement influencing continuation desire some of the juiciness effects in the visual category have bigger impact on continuation desire than others. The task of this research is to compare these effects' impacts within a puzzle game designed specifically for this experiment. Through iterative design and testing some of the aforementioned effects will be dropped due to their lower impact or unsuitability in order to establish the final comparison between the two most important visual effect categories.

Therefore our problem statement can be summarized as follows:

> *Does any of the following visual elements: animation, particles and light, have different positive impact on continuation desire than the others while, playing a numbers puzzle game.*

It is also possible to establish a baseline hypothesis that will serve as the primary research question.

"H_0: There is no difference between different visual effects' impact on continuation desire."

"H_1: There is a significant difference between the impacts of different visual effects on continuation desire."

If the experiments manages to disprove the null hypothesis it should then be possible to rank the individual elements based on their continuation desire impact.

2.9

Design of Experiment

It has become evident that there are multiple different juiciness effects that need deeper investigation. However, before those elements themselves can be tested, there are other requirements that need to be fulfilled. The strategy resulting from this is revolving around iterative design, rather than developing and testing in one pass.

First iteration targets general game idea and usability. In order to reliably perform an experiment and obtain valid data it is necessary to have an understanding of how the user will interact with the game and how we can develop the best controls, feedback and immersive elements which Sweetser and Wyeth concludes by GameFlow (Sweetser and Wyeth, 2005).

The next iteration should take the above research into account and develop the game with the feedback obtained from the players. After the general development is completed, the juiciness effects will be implemented which will then serve as the target for testing during the second iteration

The experiment will be centered around which juiciness effect provides the highest level of impact on continuation desire. With more than two juiciness effects in play it would be advisable to select the two most prominent ones and advance those to the next iteration.

With the results and feedback from the second iteration, the research will advance into the third and final iteration. The final experiment will test the two most prominent juiciness effect against each other. To find out which juiciness effect is the most important one when designing games and, for further research, aimed at all who are designing games, which juiciness effects is the most important in regards to continuation desire.

2.10 Game Design Requirements

Game design will guide the development of the game as well as help fulfill the requirements for successfully answering the research question.

Research into games that utilize juiciness lead us into the territory of puzzle games. Based on the findings of other scholars the genre for the game should therefore be a puzzle game, more specifically a numbers puzzle game. Buckthal (2014) warns that it is necessary to properly teach game mechanics to players in order to obtain valid results and Linehan et al. (2014) add to this that different mechanics should be taught across different levels.

Although the genre has been decided based on other research, none of the researchers mentioned anything about a specific required theme. Therefore it has been decided that the theme for the game can be left as an arbitrary choice by the writers. Since both of the authors share a great interest in nature, we choose to develop a numbers puzzle game where you have to plant different trees to create a forest.

It has been decided that in order to provide a pleasurable experience for the players, the game should comply with elements from the GameFlow theory (Sweetser and Wyeth, 2005). In particular:

- **The Game** - A task that can be completed (A clear set of goals for the player)
- **Feedback** - The task provides immediate feedback (Provided by the juiciness effects)
- **Control** - Allowed to exercise a sense of control over actions (Players should be able to impact whats going on in the game)
- **Immersion** - Effortless involvement, reduced concern for self and sense of time (Higher polish, and quality of implementation to increase the engrossment)

It has been concluded based on prior research that the three juiciness effects in the game are going to be animations, particles and lights. Therefore it is necessary to describe the requirements for these effects that will undergo testing later and how they will be implemented into the game.

2.10.1 Game Elements: Juiciness Effects

In order to create a fair comparison between the different juiciness effects it is important to think about how they are going to be used. The proper way to do this is having different versions of the game containing only the specific juiciness effects. It is worth noting that it is necessary to use all the different juiciness effects for the same purpose. For example if a death of an object is accompanied by a dying animation in the animation version of the game, the other versions should try to emulate the same level of effect by using their respective juiciness effects category. In other words the particles version should display dying particles and the lights version should show lighting that indicates death.

The criticism of Juul and Begy (2016) accompanied by the findings of Kalyuga et al. (1999) sets up the requirement that none of the juiciness effects should be redundant and should always provide feedback or information about the game state to the player.

Since Adams (2009) stresses the importance of sound as an effect, sound should be present in all versions of the game, but it is not going to be the main testing target since the research is focused exclusively on visuals.

3

Methods

Due to the sparse previous research in Game Juice and Juiciness effects this experiment will be centered around the different juiciness effects which the puzzle genre uses. We want to collect qualitative data due to us using the continuation desire questionnaire and methodology by Schønau-Fog (2011). The resources we collect is due to us doing explanatory research, since our topic of field is an unexplored field where only vague research data is available. We wish to investigate and seek more knowledge in juiciness effects we therefore want to combine the visual effects and the continuation desire method to synthesis new data and hopefully we can lay the initial groundwork for future research. (Kowalczyk, 2015)

The exploratory research design suggest the use of both qualitative and quantitative data collection (Teddle, 2003) When extracting our research data from the continuation desire method we will furthermore use an exploratory sequential mixed methods where we analyze our qualitative data and then interpret all our qualitative data to quantitative data. (Bjørner, 2015) Furthermore, our approach can also be defined as a sequential mixed method procedure, since we both combine the qualitative and quantitative aspect. (Creswell, 2003) The reason is that by combining both qualitative and quantitative data we can extract more specific data and get a better understanding of our research field then using either approach alone.

3.1 Test Procedure

Through this semester we will develop three main experiments and we will develop them through iterations (Rouse, 2009).

The first test will be centered around usability of the game where game mechanics and gameplay will be put to the test.

After validation from the first test and feedback on how the development should continue. The game will be improved and a second test created where the focus will be upon the juiciness effects - the three different effects being animations, particles and lights. These will be tested as independent groups.

In case of disproving the null hypothesis the weakest group will be dropped with the rest continuing into the next iteration.

We use TRUE methodology - tracking real time user experience and pop up questions between each level.

We will use continuation desire questions in our questionnaire and in our second and third test we will ask them how much they want to continue after each level. (Schønau-Fog, 2011)

4

First Iteration

The first iteration is mostly going to contain information about the general development of the game and the initial usability test for the product.

4.1 Design

As mentioned and argued in the research chapter (Chapter 2), a numbers puzzle game with a forest theme has been selected, therefore the initial focus is going to be on designing suitable game mechanics.

The game itself is going to be placed on a hexagonal grid, to comply with the numbers puzzle category, each hexagon will be assigned a value representing its fertility (or amount of resources it can provide). These values will not be directly visible to the player, however they will manifest themselves in the way the different hexagons look (For example a fertile tile should be greener that a non-fertile one.). Inspiration was drawn from different games who also uses hexagonal grid like Settlers - Catan (*Settlers*, 2017), Civilization (*Civilization VI*, 2017) and Niche survival game (*Niche Game*, 2017), see figure 4.1.

The player's task is going to be planting trees on these hexagons. Each tree should have needs that need to be fulfilled by the hexagon in order for the tree to survive. Base mechanics were heavily inspired by Conway's Game of Life (Gardner, 1970) in the sense that hexagons and trees should have a set of defined interactions and rules.

Different trees should interact with each other, creating a puzzle scenario where for example a specific position on the grid will not be fertile until a correct tree is placed in the vicinity.

Similar to real life, trees should be able to reproduce, thus growing the forest. Player will either be scored on the amount of living trees or on completing other objectives.

In order to create a functional game a set of systems that supports the proposed game mechanics has to be drafted and created. Furthermore, it is

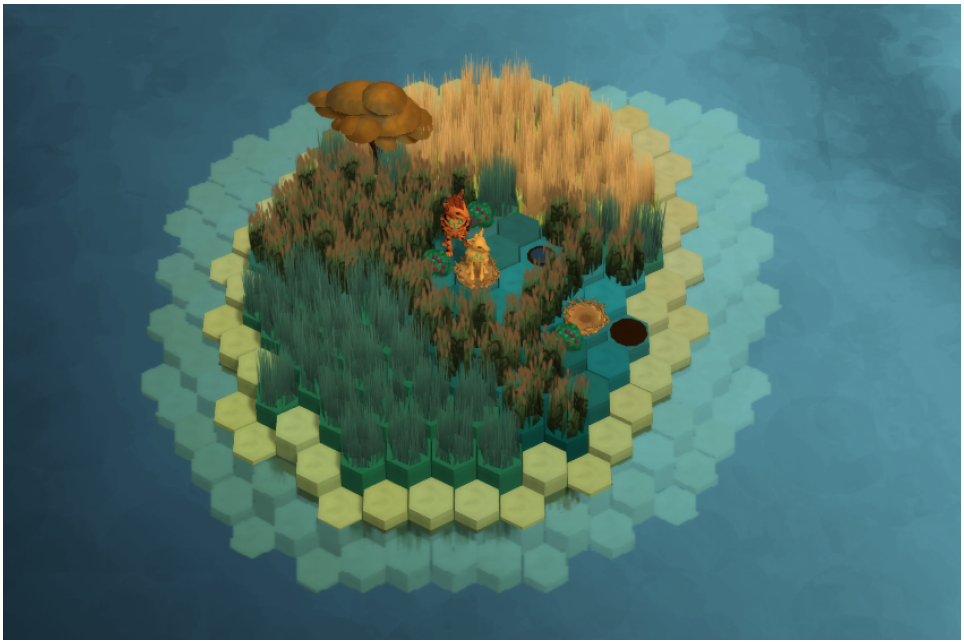

Figure 4.1: Inspiration to our hexagonal grid game mechanics was inspired by games like Settlers, Civilization and Niche survival game, pic. above

necessary to create all the assets (3D models, textures, graphical interface) and insert them into the game.

4.2 Implementation

The game itself has been developed in the Unity3D game engine (*Unity3D*, 2015), due to its freeware nature as well as the authors' experience using it. 3D assets were created in the Blender modelling software (*Blender*, 1995) with textures for these assets being created in Adobe Photoshop (*Adobe Photoshop*, 2017). An example of a 3D asset can be seen in figure 4.2 and the same asset but now with textures applied to it can be seen in figure 4.3.

Three different types of trees were designed for the game. These were:

- **Pine** - Easy to grow and maintain, rewarding few points.
- **Oak** - Moderately difficult to grow, but provides bonuses to hexagons when placed near Pines. Worth medium amount of points.
- **Cherry** - Hard to grow, but worth many points.

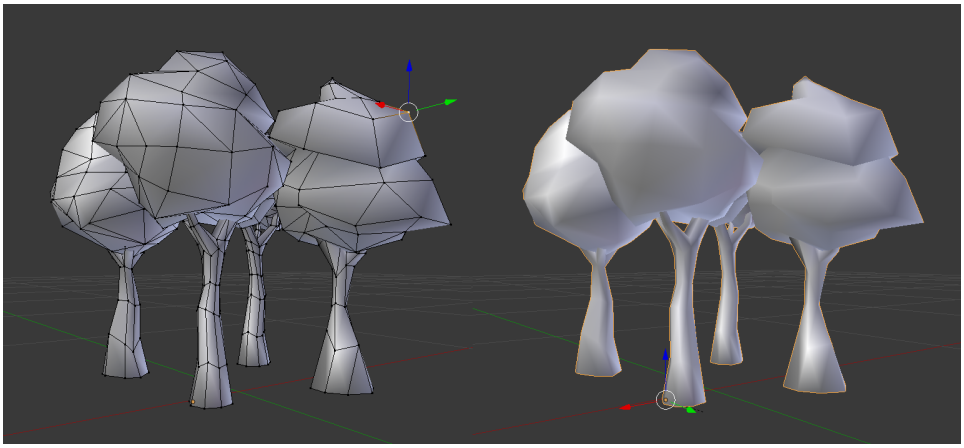

Figure 4.2: Cherry tree being created in Blender with wireframe and as 3D model

Figure 4.3: Cherry tree being created in Blender with wireframe and as 3D model

4.3

Evaluation & Results

The first experiment was conducted on the 10^{th} of March 2017 during the opening event of S.M.I.L.E (Samsung Media Innovation Lab for Education).

Due to the event having many different exhibitions, the best solution was developing a small game test which would make it easier to get participants. The test was revolving around the usability product, how the software worked and how test subjects interacted with the game. Participants in this test were competing for a high score in the game.

The questions asked regarding the experiment were questions centered around the game algorithm, whether the forest simulation seemed real, and what could be improved within the simulation. Other questions were generic questions about game design and game balance.

The test setup was a computer with a ultra wide high definition screen. The game was controlled by the combination of keyboard and mouse.

The experiment included 22 unique test participants. Some participants played the game more than once. Their gameplay was observed and any issues with the game noted.

14 participants said that the forest simulation seemed natural, 2 participants said that it did not feel natural at all, and 6 said other.

Under other they elaborated:

> "*That the changes was too fast, so it's hard to imagine what the growth would look like*"

On said that the results seemed natural but the controls did not seem natural, however the controls we had created for this prototype was not a finished edition.

Some of the other comments were:

> "*It seems to provide some naturality*"
>
> "*Dynamic, but artificial.*"
>
> "*The forest seems to imitate natural development/growth well.*"

In our first experiment we had different questions regarding improvement to our forest simulation and game. Many participants had some of the same notions, therefore we choose to quantify the questions and create a table from the answers. See table 4.1

Table 4.1 shows that nine players wanted an introduction, tutorial, objectives in the game and guidelines on how to play. Eight participants needed

Improvement table

	Tutorial	Feedback	Interactions	GUI	Visual FB	Time
Amount	9	8	3	2	2	2

Table 4.1: Table over the improvement feedback we collected from our first experiment

more feedback in the game when planting the trees which were growing etc.. Furthermore two participants also wanted more visual feedback and graphics, where they could see where they actually planted the trees, because there was no visual indicator. The players wanted feedback when they got a bonus from pines and oaks which comboed [1] each other. They also needed more feedback when trees were planted.

Three participants wanted more feedback when doing actions in the game, and more influence in controlling the trees in the game. Furthermore two players thought that the trees was growing to slow and that more flow would be better.

19 thought that the strongest tree which was best to survive was the pine tree, which also seemed true. Furthermore we asked it it felt natural that the pine tree was better than the other ones - some of the answers obtained were as follows:

"*I guess it fits with the point system*"

"*Don't know the biology of trees*"

"*Yes, because it takes less resources" / "It is more "stubborn""*"

"*Oak, should have been stronger*"

In addition, 15 participants simply answered "yes".

Some participants also had ideas for improvements, some of these were: *Watering, Nutrition = 2, Bush, Introduce animals = 2, Village, Roads and Farming*

Key Points to Address

As seen from the participants' answers one of the major concern was the lack of interactivity. Going back to the research it is evident that it is a problems as control is one of the categories in the GameFlow theory that we decided to follow. This calls for a change in the way the players plant the

[1] A term stemming from "combination" - a series of actions that, when performed either together or in the right order, give a bonus bigger than the sum of all parts

trees since during this iteration they were only allowed to plant three and the rest was done automatically within the simulation.

Other major point was the lack of feedback. This was to be expected as juiciness effects were not planned for this iteration. Therefore it seems like a good sign that they might have an effect on the players enjoyment of the game, which is also confirmed by results of other scholars mentioned earlier. The lack of feedback will be addressed by the implementation of the different juiciness effects during the next iteration.

5

Second Iteration

In the second iteration the key points from the conclusion of the previous iteration will be addressed and resolved. The main objective of this iteration is to create, design and implement the three necessary juiciness effects (animations, particles and lights), which will then be put to the test.

5.1 Design

5.1.1 Design of the Experiment

This experiment is going to use between group testing with three groups of participants, each assigned a different version of the game containing one of the selected juiciness effects.

5.1.2 Design of the Game

When redesigning our game we based on the feedback from the previous experiment and the knowledge from the analysis chapter and design requirements. Linehan et al. (2014) concludes that game mechanics should be taught across multiple levels. Therefore the new version is going to contain 5 levels, where the players will be taught the game mechanics, such as tree planting, how trees survive, how trees die and how trees affect each other. All versions of the game now contain a victory screen which appears after a player successfully completes a level. The purpose of this screen is to compliment the player to motivate him to continue. The victory screen is equipped by a juiciness effect matching the version of the game.

As mentioned in the research chapter, all juiciness effects should be used for the same purpose in the respective version of the game. It is necessary to describe these occurrences in order to have an idea about how to implement them.

First place where the effects are going to be applied are the trees themselves. The juiciness effects will be used to inform the player about the state

of the trees.

The four different states of the trees are:

- Alive - Idle
- Alive - Heavy Wind
- Dying
- Dead

.

An example here could be an oak tree planted on the board. When alive and idle in the animation version it could be swaying lightly with the wind. In the particles version there could be healthy green particles slowly falling on the ground and in the lights version the tree would be illuminated with a bright green hue. All three versions then express the same idea by using their own ways. This way a fair comparison is ensured. (Figure 5.1)

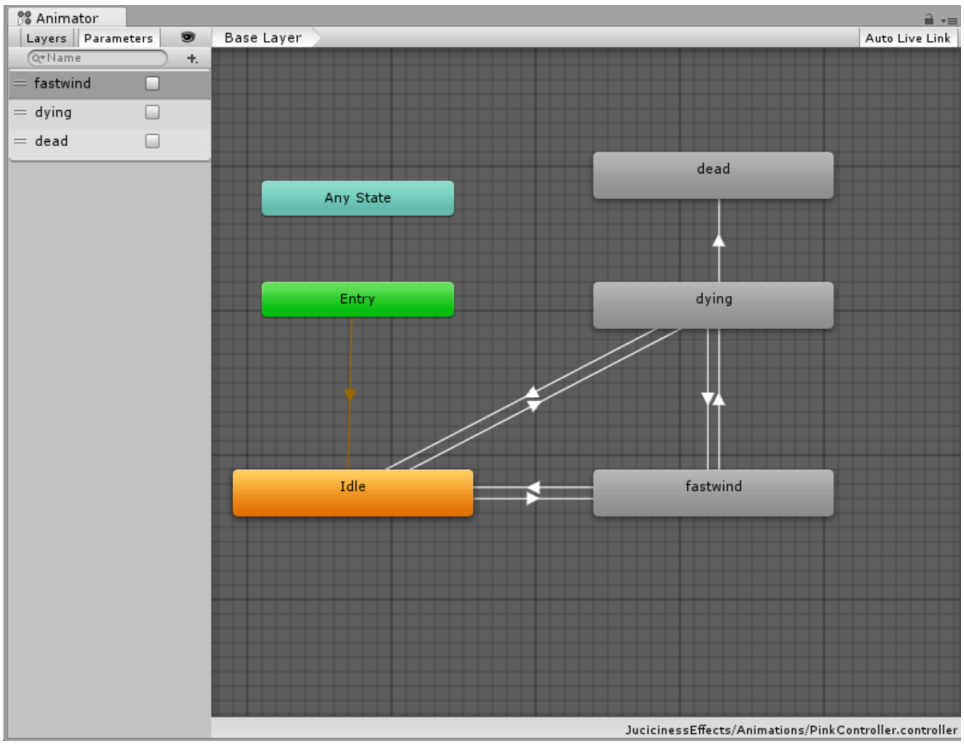

Figure 5.1: The Cherry tree animation controller were the different states are presented.

The states mentioned above imply some sort of a weather system that governs the behavior of the trees. This system will be created and the

weather should affect the state of the board - for example sunny weather should increase the fertility of the board.

Furthermore, sound will be added into all versions of the game during this iteration. The implementation of the items mentioned above is going to be described in the following section.

5.2 Implementation

5.2.1 Juiciness Effects Implementation

From our first iteration we wanted to add animation, particles and lights as the juiciness effects. The implementation of the different effects are described further in this section.

Animation

Since the animations needed to loop a set of keyframes[1] had to be created so the first and the last one has the exact same positions.

When developing the animation cycle a small problem surfaced. The animation did not connect properly and when the two keyframes were connected the animation was still easing out when connecting to the first keyframe. This problem was solved by changing the interpolation wave. As seen in figure 5.2, the wave is now properly connected.

Besides the four states the camera was also animated when heavy wind was blowing. The winning screen contains a fast spinning fade in animation in order to make it more interesting for the player.

Particles

When creating our particles system it was created in Unity, which has a particle system build in its engine, the particles are based on small images which emit light and moves depends on the different variables and rules which are specified in the particle system. The particle system was created for all tree states. The states includes an idle screen where particles would fall slowly and during heavy wind the particles would fly fast down the

[1] A key frame in game animation is a point in time holding a value of a specific variable that is expected to change. The change can be described by multiple keyframes in a sequence.

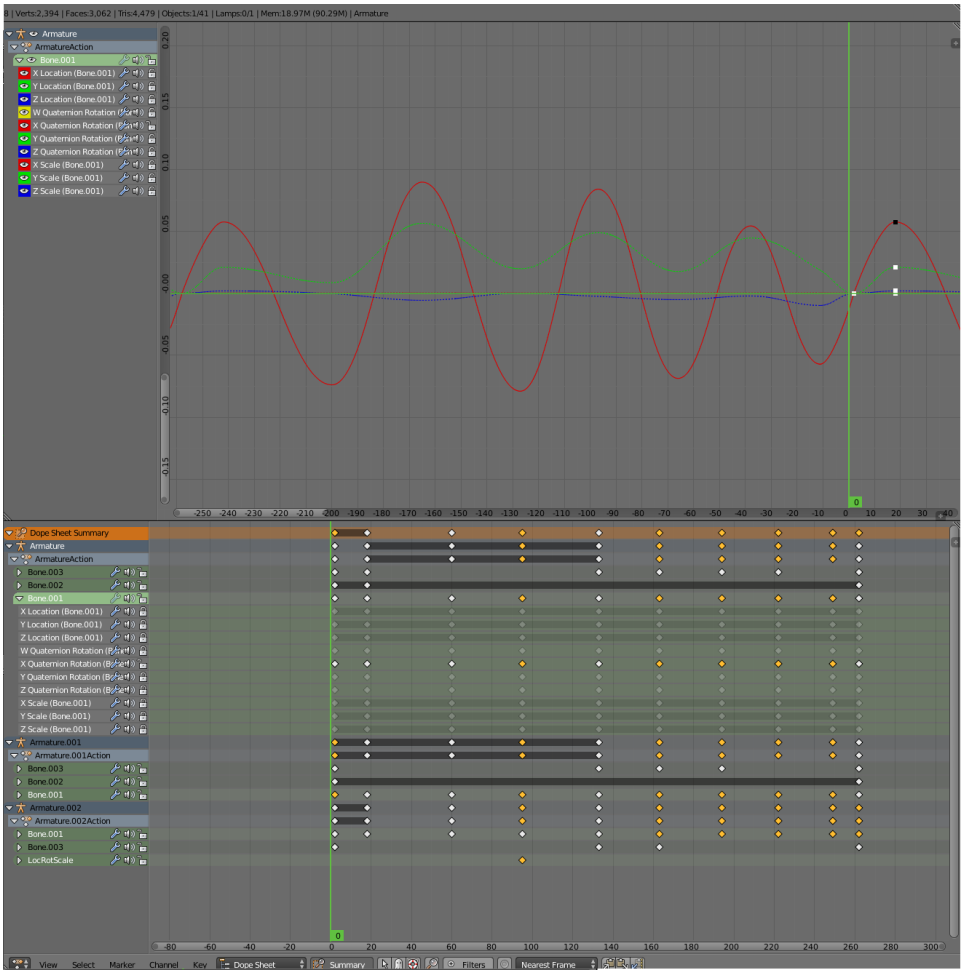

Figure 5.2: The Pine animation wave interpolation fix. Note the smoothed animation curve.

screen. When a player won the level a winning screen with particles would pop up and a particle star would shine behind the winning screen.

Lights

A light system was created in Unity including a light controller where different colors was turned on and off depending on the tree states and the weather system. Also a vignette was added to the screen with a blue color which alpha value was changed from strong to weak to imitate the heavy wind weather.

Sound and Music

Besides the different juiciness effects which a sound and music system was included in all the different versions. All the different juiciness effects had the exactly same sound and music. The sound effects were obtained from freesound.org (*Freesound*, 2017). The effects were cut and a fade in and fade out effect was implemented on every sound file. The sound files used were

- Tree successfully planted
- Winning sound
- Ambient weather sounds (sun, rain, wind)
- Music

Furthermore a music composition with a very soothing fairy tale melody which fit the game theme very well, from a composer Jacob Lynggaard from Sound and Music Computing education (*Sound & Music Computing*, 2017) *Jacob Lynggaard Olsen - MFYG* (2016).

5.3 Evaluation

5.3.1 Qualitative Evaluation

The second test included 60 participants in three groups where each group had one juiciness effect. Those were animation, lights and particles.

The experiment was set up and ran from 24^{th} to 25^{th} of April. It included a qualitative questionnaire, in-game data that were measuring the continuation desire as well the test conductors observing the test participants while going through the game. The next sections will go through the results that were gathered from this experiment.

5.3.2 Game Mechanics and Continuation Desire

When testing our project and going through the qualitative answers throughout the questionnaire it became very evident that many players thought that the game needed more actions and many again though that there was a lack of interactivity, the players could only do 3 actions on every tile, and it seemed like many players wanted much more interaction, many thought it was frustrating that the trees automatically reproduced themselves and they could not spread them manually where they wanted to.

Some also thought that the game was somewhat slow and they wanted more outer events, like someone coming and cutting down the forest so they had to survive instead of just growing.

> *The challenge is what makes me want to continue. But I wanted to have more challenge in the game. Like having a man cutting down the trees or so"*

Many of the respondents did not understand the game mechanics, the same answers appeared across all three test groups. Some of the answers from the test groups were as follows:

> *"Maybe if there was better objectives. Tbh[2] I failed at understanding exactly how the trees spread which made me lose control of what i did in the last planting.", "I didn't quite understand how trees spread and how they didn't. seemed slightly random at times"*

Particles

The participants which understood the game mechanics wanted harder and more challenging levels four participants said this:

> *"I want to try some harder levels"*

Five of the test subjects in this category did not get the game mechanics and rules of the game:

> *"I don't think I completely understood the rules"*

Animation

Eight participants did not understand the game and game mechanics:

> *"I didn't quite get how the different trees affected adjacent tiles, I know it did something, but not exactly what it did"*

One participant wanted more challenging levels:

> *"Hoping for future challenges!"*

Lights

> *"I do not want to try the same levels again. Though I would like to try new."*

[2]Note: TBH = To Be Honest

Three participants said that they did not understand the game mechanics:

> *"Well unsure about the game part of the game"*

And furthermore two said they did not understand the goal/objectives of the game.

5.3.3 Juiciness Effects

Contrary to the game mechanics feedback, the juiciness effects answers were more positive:

Particles

16 of the answers were positive and very positive:

> *"Very nice", "They were nice and somewhat professional ", "it was pleasant to the eye", "its nice, simple and clean" and "They fit the simple design"*

Furthermore one participants wanted more in the background:

> *"Very nice, maybe add some more visuals to the background (I know it might take focus, but something small too look at would be cool)."*

Another one thought the menu screen looked odd:

> *"I felt the leaf texture on the menu pop op looked a little odd however."*

And one thought the music was irritating:

> *"visuals were nice, music was a little irritating"*

It has been observed throughout the test that participants got a little irritated by the victory fanfare implemented in the game.

The question: *"I like the visual effects in the game"* which was a Likert scale question from 1-7 where the Median from 20 participants was 5.5 .

Animations

10 Positive comments:

> *"They were coherent and nice. Fitting", "The visuals corresponded well with the game"*

Four comments about feedback and improvement:

> *"Didn't like them, since they made the game seem clunky", "It made sense, but they were not stunning", "What visual effects?*

Some reported bugs and that they did not understand how the tile system worked:

> *"Pretty nice. The color changing tiles were a little confusing, grey to green. the trees also seemed to come back to life after a little while of being dead, not sure why", "nice graphics, sometimes it feels like it stucks", "Hard to see the difference between the color of the tiles sometimes. Trees looked fine, but a little hard to see if they were "grown""*

Three participants had negative comments regarding the animated spinning winning screen:

> *"i liked the look of the trees and map but the complete level graphic didn't fit in", "The spinning card animation was a little too long", "Fine, minus the swirling thing after each level.*

The question: *"I like the visual effects in the game"* which was a Likert scale question from 1-7 with the Median value of 5.

Lights

14 of the participants had positive comments regarding the experience:

> *"I enjoyed it!", "The visual effects were relaxing.", "They were low poly and simple. I like that style."*

Feedback and improvements around seven of the participants had ideas for improvement of the experience, and some did not notice the juciness effects at all but instead were commenting on the general look of the game.

Regarding the background of the game and how the tile system worked:

> *"Simple, but works. Could use something other than a blueish background.", "Nice and simple. Calming. (a bit confusing with the different colors of the tiles)", "I like the cartoony look of the trees. The tiles however looked a little more "lifeless"."Looked fine. Colors were nice. But couldn't always see where a tree could grow since the tiles got highlighted by its neighbours.",*

One of the participants also noted the lack of animations in the Light build of the game:

> *"They are rather simple. I would have loved some more textures and organic feeling. Everything felt very stiff - Might also be the lack of animations and moving things. Everything just popped up and away."*

The question: *"I like the visual effects in the game*" which was a Likert scale question from 1-7 with the Median of 5.

5.3.4 Quantitative Evaluation

Together with the questionnaire results, the other part of results gathered was in-game data captured as a Likert scale value from 1-10 after each level in the game. This provides us with a representation of each participant's continuation desire as time progressed. Since our research question is based around seeing whether there is a difference between the different groups when it comes to continuation desire it would be very fitting to use correlation between time and the Likert scale answers as a measure of potential drop or increase in continuation desire.

Condensing the information from five different measures (one per level) also makes it easier to apply other tests to see whether there is truly a statistical difference between the three groups.

The transformed data was tested for normality using *One-sample Kolmogorov-Smirnov test* (2017) and for equal variances using *Bartlett's test* (2017), both returning positive results.

The decisive result of MATLAB's *One-way analysis of variance* (2017) was that there was absolutely no statistical difference between the tested groups, with $p = 0.96$. Visualisation of this test can be seen in figure 5.3.

5.3.5 Discussion

The question is what do these results tell us that can be helpful for the next iteration. The major point here is that the in-game data does not show any form of difference between the tested groups. It can be argued that the lack of a control group makes it potentially unclear as to if the lack of difference can be attributed to all types of juiciness effects having the same impact (in this case the control group could exhibit lower/higher values) or if the results were affected by some potential bias.

As the questionnaire results show, grand majority of participants had some form of an issue or problem with the game. In general, clarity and ease of use were major concern as well as player not fully understanding the underlying mechanics of the game. This could very well be the case for

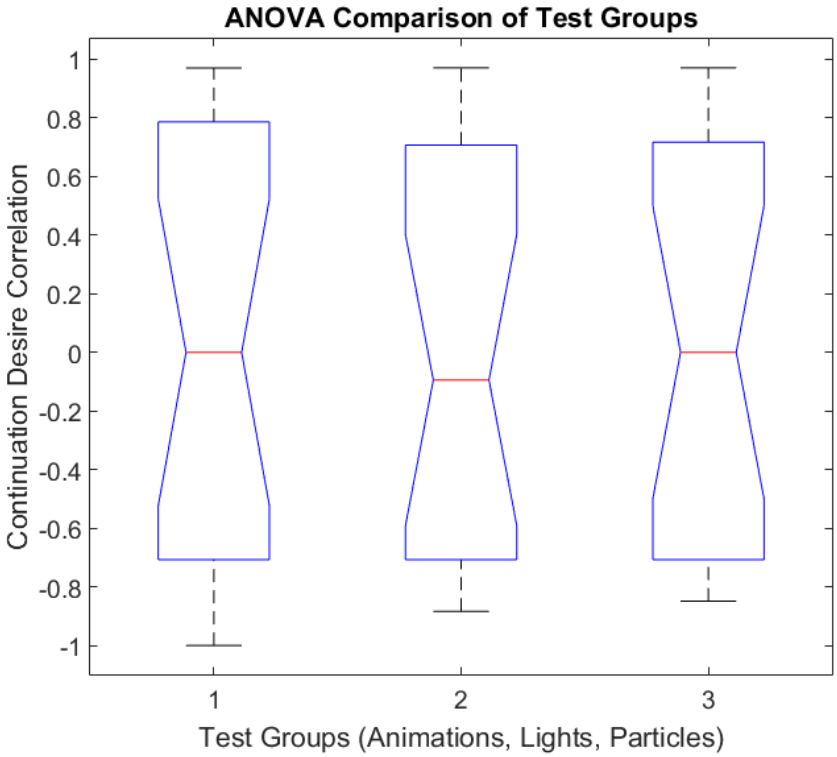

Figure 5.3: ANOVA comparison of the three test groups

the homogenity of the in-game data. The fact that the players were very confused about the workings of the game could be a valid reason for the equal drop in continuation desire in all three categories as the nature of the problem could obscure the players attention to the effects, thus diminishing their potential impact on the player.

Key Points to Address

Some complained about the hexagonal grid system, which was not taught well enough through the tutorial in the game. The grid system was somewhat confusing for the players and the reason why suddenly some of the tiles shifted their color, this was because of the trees' functionality which did not have a connected tutorial. This leads to the conclusion that either all the mechanics should be made clearer (for example a better tutorial) or the more complex ones removed from the game.

Furthermore many of the participants from the different groups pointed out that it would be good if there were more to the game, some who had the lights version complained about missing animations, many of the partic-

ipants thought that the experience was very simple and it needed "more", which could be "more" juiciness other than the one visual effect which they had in the build they were playing. Many answered that there were not any special effects or had not noticed the visual effects at all.

Some from the animations group did not notice any visual effects at all, they might have observed the animations but did not account for it as an visual effect. The point here for the next iteration is that all juiciness effects should be made bolder or more visible to the player as too many of the participants commented on the general look of the game instead of what the question actually asked about.

Unfortunately the experiment failed to disprove the null hypothesis. The idea here is that the results were potentially too biased to be taken seriously. There are small pointers across the different data gathered that the particles group was slightly better performing when it comes to providing continuation desire than the others. However at this point it could also be down to chance. A necessary step in this regard is the addition of a control group as it was possible that all the juiciness effects are on par when it comes to influencing the will to continue.

5.3.6 Changes in Experiment Structure

Although it was originally planned the drop one of the juiciness effects at this stage of the research, the results from the second iteration force us to repeat this test once more, this time with all the problems that manifested themselves during this iteration addressed.

Therefore the third iteration will still contain all three categories of juiciness effects as well as two control groups. One additional version of the game will not contain any juiciness effects at all. This version will be expected to perform worse than the individual effects groups. Another new version will contain all three juiciness effects at the same time. This group will be expected to score either better or on par with the individual juiciness effects groups.

6

Third Iteration

Third iteration is our last iteration within the scope of the master thesis and this chapter goes through our design which are based on the results and qualitative and quantitative answers from our second iteration experiment. The implementation chapter goes through these design changes and how they are implemented which includes the game mechanical effect and the graphical and the juiciness effects. The last section in this chapter will be about our last experiment and the results and discussion of these results.

6.1 Design

6.1.1 Design of the Experiment

Designing the third iteration it was decided to keep the structure from the previous iteration, only this time with five groups of participants each testing and completing a different version of the game. It was decided based on the previous results, that the conditions and independent versions were animations, lights, particles, all effects and no effects.

6.1.2 Design of the Game

When iterating upon the game the feedback from the previous iteration has been taken into consideration and the main points were addressed

Changes in Hexagonal Tiles

Since many participants did not understand the tiles and how they changed, it has been decided to make it clearer to see the outcome of the placement of the tiles by making the grey tiles either green if they were positive and had good nutrition values to place the trees upon and red, if it was a bad place to place the trees upon. (Figure 6.1)

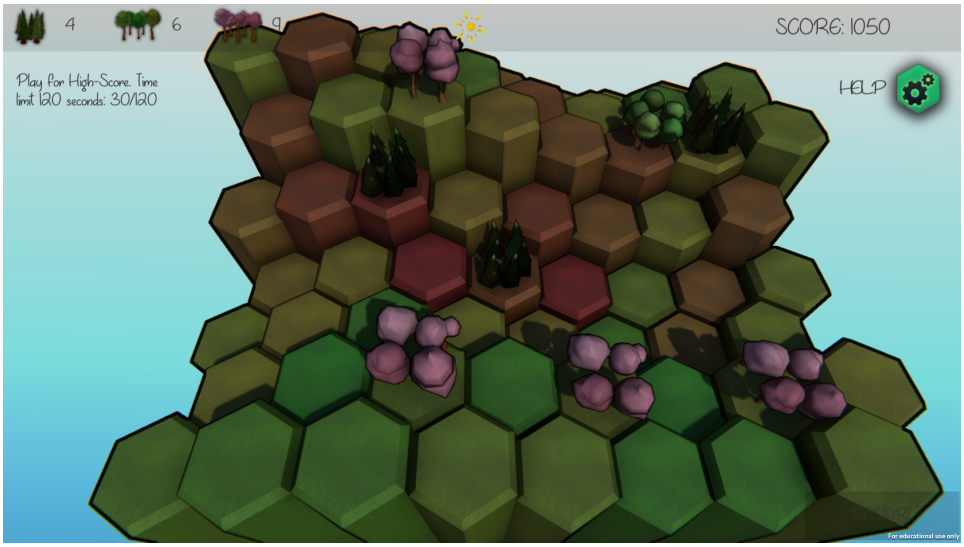

Figure 6.1: Tiles in the third iteration

Help Menu

Since some of the test participants did not understand how the trees reacted to each other and how they influenced as well as gave bonuses to each other. Therefore it was decided to develop a help menu which explained this, as well as the game mechanics.

Goal

The score value from the first iteration has been reintroduced, since many missed a goal for the game, and it seemed that many participants liked the first version were score value was presented, It was chosen to add a Score value again, and a last level where the goal was to get the highest score possible.

6.1.3 Visual Effects

Lights

Since some did not notice the light effects, it was decided to make the light more "alive", by making them react to weather on each independent tree tile.

Animations Winning Screen

Since some complained about the winning animation screen the winning animation will be changed in the animations version. The old winning animation seemed somewhat slow, and the test participants had to wait for the full animation before they could progress to the next level.

Sound

The first victory sound was very loud and long, many participants complained about this sound, also when they were observed, but some also wrote it in the questionnaire.

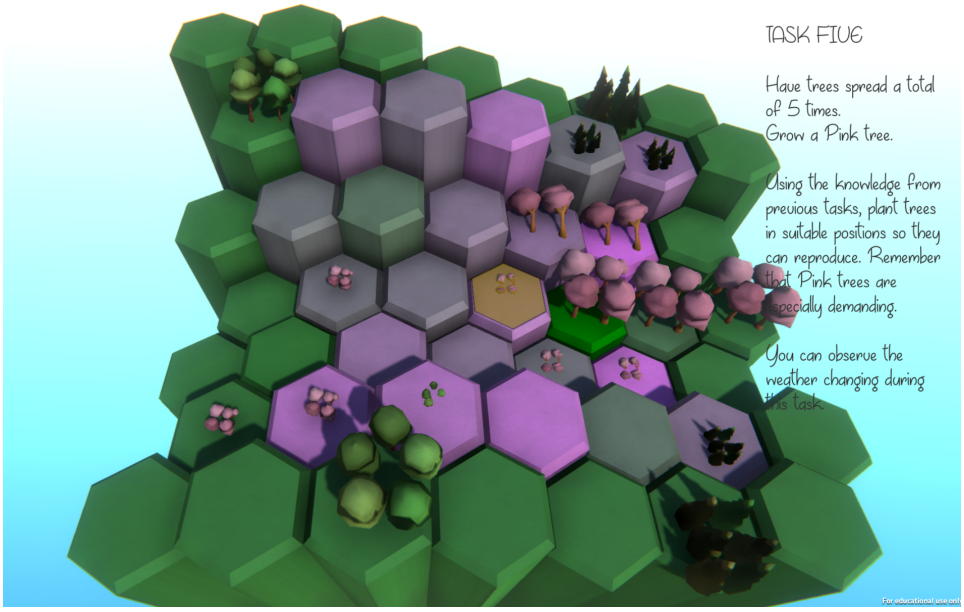

Figure 6.2: Tiles in the second iteration

6.2 Implementation

Hexagonal Tile System

The tile gradient system identifying the health of each tile has been changed from green-grey/pink gradient to a green-yellow-red gradient in order to increase readability. Furthermore the tile textures have been changed to make it look like every tile had grass on it. (Figure 6.1)

Help Menu

The help menu contained all the information regarding the way the tile system game mechanics worked see figure 6.3.

Figure 6.3: The help menu containing infromation about the game mechanics

Animation Winning Screen

Since the victory animation in the second iteration was very slow, many participants from this group noted that it was very slow and not very good. Therefore all the key frames were compressed in Unity and which made the animation faster, thus making it look more responsive and it felt better when playing the game. The victory animation length went from 3 seconds to 1.15 seconds.

Outline Shader

A pre-made Unity image effect filter was applied to the game. It was a post processing edge detection filter, which finds the edges in the game and applies a black stroke to it. It is a very nice detail to the game and made it look better compared to the second iteration. See figure 6.1.

6.3

Evaluation

The evaluation chapter in third iteration consist both of a qualitative evaluation, a quantitative evaluation and a discussion thereof. The qualitative evaluation uses exploratory sequential mixed methods where the qualitative results are quantified by measuring how many participants have the same meaning regarding a subject. Furthermore the quantitative evaluation consists of MATLAB analysis of the results from the experimental groups. In this iteration five groups were present, each version with an independent variable (animations, lights, particles, all effects, no effects).

6.3.1 Qualitative Evaluation

The qualitative evaluation is made out the three main juiciness groups animation, light and particles and the two control groups - all effects and no effects. This section is containing quotes from different test participants and a quantitative collection of their answers.

Animations

14 out of 20 test participants mention the game mechanics in the questionnaire, most did not understand the game mechanics while some instead thought it was a bit to easy, but in general most did not like the game mechanics:

> *"Well, the game mechicanics wasn't that clear, so I wasn't sure how I was suppose to get a higher score.", "no intuitive way of strategising""I didn't get the purpose, or it was difficult to understand how you could win or loose" "the game was okay. But it was not very challenging which is kind of a deal breaker for me"*

Regarding the visuals effect 12 comment were very positive

> *" I personally am a fan of tiled infrastructure and I think it was feasible to see tiles of any heigh", "I think it was nice. I liked the colors", "they were good"*

Lights

In the lights test group 12 mentioned the game mechanics:

"It is kind of borring and I'm not sure that I understand the gameplay", "I didn't really understand the underlying gameplay"

Some also mentioned that they needed a tutorial:"

I needed better explanation for the game

The visuals answers were most positive with a collection of 11 participants:

"very simple" "Very impressive ""cartoonish, simple, and kind of cute. "

Some also had some ideas to visual improvements:

"I like it - but didn't figure out what the color change ment" " Nice. Very simple and nice colors. I didnt like that the introduction was written in white"

Particles

In the particles group 17 mentioned game mechanics some were more positive, in a sense they would like to learn the game mechanics while other found it to hard:

"I didn't reeeeeaaaally get it/ I think it had more strategic elements ", "I didn't quite get the rules of the game, so I would like to explore those further", "I didn't really understand the point system or how the trees affected each other"

Some were interested in a tutorial as well due to the game mechanics:

"I was a bit confused about how the trees influenced each other. A tutorial sharing how the mechanics works would maybe help. "

Regarding visual effects 15 participants had a positive answer:

"They were nice and soothing", "very impressive", "game looked great", "They were nice. Combined with the music it gave a sweet, carefree atmosphere", "They fit the simplicity of the gameplay"

Three test participants had some ideas to improvement of the visuals:

"I like the simplicity, but it could use a little work in the scaling of the elements.", "They are nice in their current state, but not visually mindblowing. Could use some more context (the background in the game etc.)"

Regarding the background color we almost did implement some clouds, but since it did not feel like it fitted in, thy were removed again, but it might be interesting to look at background visuals as well, if developing the game further.

All Effects

In the all effects group there were 10 negative feedbacks regarding game mechanics. The test participants noted following:

> *"I did not get it at all" , "The purpose of the game was not stated clearly"*

A couple two to three participants also answered more positive comments

> *"I want to beat the high score", "It was interesting", "I sort of understood the objective of the possibilities of the game that I want to try and experiment with more"*

Regarding visuals, the answers were very positive 18 participants said they liked them and the answers were positive.

> *"They were alright. Cartoony in a good way." , "that they where simple, and did not take too much attention from the game"*

> *"nice visual effects, not too intrusive and helps you immerse yourself in the game."*

No Effects

Seven participants did not understand the game mechanics or the game.

> *"Didn't understand the game", "I would like a guide, so I know what I'm doing"*

However some of the comments regarding game play were more positive and some even had some ideas to improvements:

> *"I feel like i could get top points if i had read the goddamn tool tips... but men dont read tool tips", "Interesting concept"*

> *"A ladder where i can compete with my friends"*

> *"I wish the game was more complex but I want to continue because last level was different and I hope if I continue to have different levels"*

The answers for the visuals questions were mostly positve with 14 having a positive reaction to them:

> *"Simple, but effectfull,", "Best part of the game", "Nice relaxing colours, they fit to the theme well"*
>
> *"I like the colour plate, it gave a good sence of the rules."*

Three had some notion and ideas to improvements:

> *it looked good, although the height difference of the map was not clear if it had an effect.*
>
> *I miss some immediate feedback when clicking through the menus as the game at times is a bit slow, so I don't know if I've pressed something and then I might click it again thus screwing up.*
>
> *I really like the low poly style, would be nice with some more details. (As birds, logs, stones and such).*

6.3.2 Quantitative Evaluation

In this section we are going to present and display the quantitative data obtained during this experiment.

Questionnaire Data

Besides general questions about the experience, participants were also asked to answer questions about their eagerness to start the experience and then asked again after the experience was over about how much do they want to try again. This data is visualized in table 6.1.

Continuation Desire Before and After

	Animation	Lights	Particles	All	None
Median - Before	5.50	5.00	5.00	5.50	5.00
Median - After	3.50	3.00	4.00	3.50	4.00

Table 6.1: Differences between the eagerness to try / try again before and after the experiment

Since all participants started the experience "blindly", meaning they had no idea what was about to happen. Therefore the eagerness to start the experience should be roughly the same for all groups. The important point here is how has this value changed during the gameplay (described in the next section) and after the game was over. It is visible that the particles

and no effects group have suffered the smallest drop in desire to start/try again.

Another question asked after the experience was participants' rating of the visual effects (Table 6.2)

Visual Effects After the Game

	Animation	Lights	Particles	All	None
Median	6.00	5.00	5.00	5.00	5.50

Table 6.2: Visual effects in the game as rated by the participants after the experiment

Since mean and standard deviation is not good to use on Likert scale since it is interval data and not ratio data as Susan Jamieson claims (Jamieson et al., 2004), we have chosen to also perform a non-parametric Kruskall-Wallis Test (Matlab, 2017) on the visual effects numbers. With a $p = 0.77$ it does not prove that the test groups come from different distributions. However some differnces can be observed in the box plot visualisation in figure 6.4.

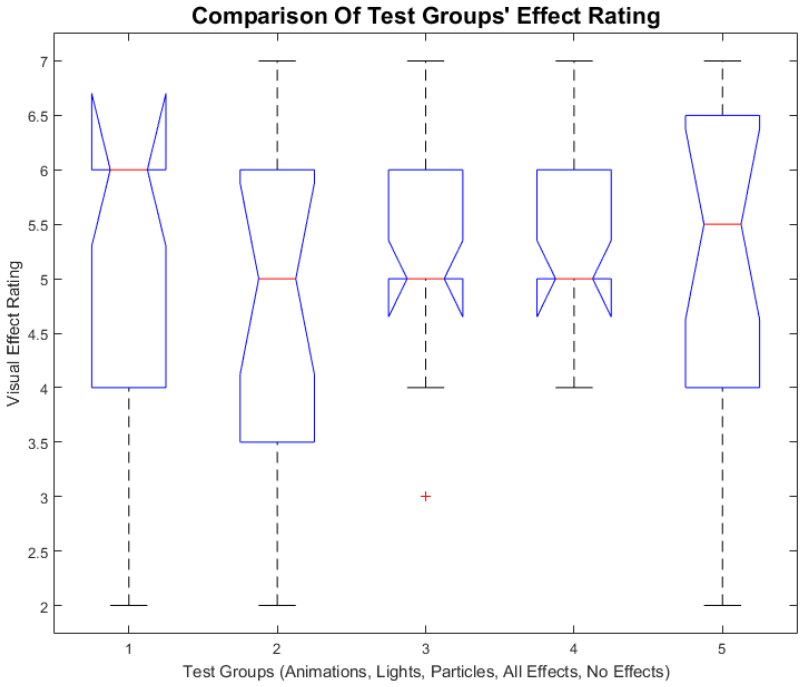

Figure 6.4: Comparison of effect ratings betwen different groups

In-Game Data

This time around the results from the game were consistent with the questionnaire results. As done on the previous iteration, initial Likert scale data has been transformed to correlation coefficients, which were later tested for normality and equal variances. However, the animation group did not satisfy the normality requirement of ANOVA therefore additional research had to be conducted whether it is possible to continue even with this defect in mind or whether it would be a better idea to switch to a non-parametric version of the test. Glass et al. (1972) and Lix et al. (1996) argue that ANOVA exhibits good robustness when it comes to not fulfilled normality requirement and only brings a small possibility of increased type 1 error rate while proceeding. Considering that only one group did not fulfill the requirement it has been decided that it is safe to continue with this parametric statistics test.

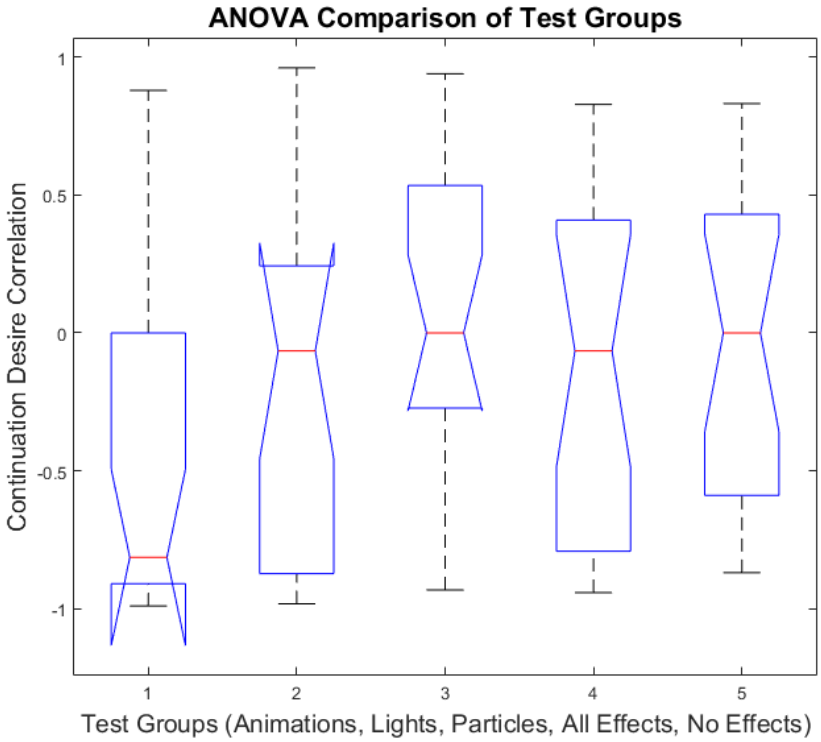

Figure 6.5: Visualisation of the ANOVA test for the different test groups

Figure 6.5 shows that this time around the results were much more decisive. With a p value of 0.16, the test is moving closer towards the realm of statistical significance.

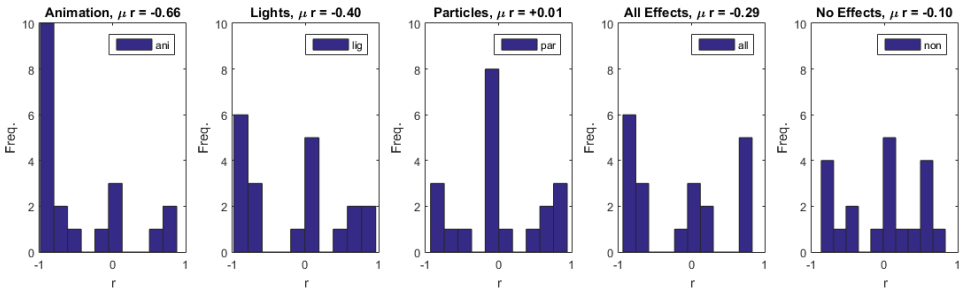

Figure 6.6: Comparison of correlation coefficients r

As can be seen in figure 6.6 the distributions follow roughly the same pattern. There are always subgroups of participants exhibiting positive correlation (increasing continuation desire), negative correlation (decreasing continuation desire) and zero correlation (no tendency observed) however the internal counts for these three subgroups are different in each test group. It can for example be observed that the animation group is very heavily skewed towards negative correlation, indicating that the majority of participants were increasingly likely to not want to continue. It therefore is interesting to look at these numbers to see if they could be condensed and represented as a single number score for each group.

Research into this problem reveals that a potential way of doing this is normalizing the correlation coefficients and therefore creating the ability to create an average without the numbers being affected by sampling distribution skew as described in Corey et al. (1998). Using some of the functions from *Homogeneity test for multiple correlation coefficients* (2009) we can transform individual r coefficient into normalized z coefficients that are then averaged into an average z which is in the end converted back into μr mean coefficients which can be seen at the top of figure 6.6.

A new data section has been introduced this iteration of the test - the time played. Participants have been asked in the questionnaire about their estimate of time played and at the same time the actual time to finish the game has been accurately recorded from within the game. The differences in real time spent and perceived time can be telling of the participants' enjoyment of the experience. The answer in the questionnaire would then be converted to seconds and subtracted from the real value. Negative numbers therefore mean that the participant estimated more than the actual amount spent in the game and positive indicate more time spent than estimated. Results can be seen in Table 6.3.

It is worth noting that the particles group had one participant who missjudged the time on a much higher level than all the others. Whereas the normal guess would commonly be within 0-3 minutes from the actual time,

Group Mean and Median Time Differences

t(sec.)	Animation	Lights	Particles	All	None
Mean	-76.75	-94.69	-46.64(-16.39)	-111.52	-42.61
Median	-45.37	-79.00	-28.15(-27.95)	-85.28	+0.90

Table 6.3: Mean and median time differences in each tested versions of the game. *Note: Value in parentheses for Particles is calculated without the extremely outlying participant.*

this participant guessed almost 11 minutes more than the real time. For this reason the statistics are presented both with and without this result.

With the individual time data for each participant, it could be interesting to display as a relation to their continuation desire correlation coefficient. Therefore we will create a correlation coefficient between the perceived time data which table 6.3 is based upon, and each individual participant's continuation desire correlation coefficient which figure 6.6 is made out of. Whereas our correlation data fulfills all requirements, our time does not. In particular the time failed to test for normality, which means a non-parametric correlation method like Spearman's Rho (Spearman, 1904) or Kendall's Tau (Kendall, 1938) will have to be used. This data can be seen in table 6.4.

τ and R_s between Time and Continuation Desire

	Animation	Lights	Particles	All	None
τ	-0.04	-0.07	-0.17	-0.05	+0.05
p	0.81	0.70	0.32	0.79	0.79
R_s	-0.06	-0.08	-0.25	-0.10	+0.10
p	0.79	0.73	0.28	0.67	0.67

Table 6.4: Correlation coefficients between the perceived time and continuation desire

None of the correlations managed to disprove the null hypothesis of no correlation, however some were closer than others. Particularly the Particles group was very much closer towards the 5% significance level. One interesting fact is that the Pearson correlation, when used on the Particles group, although not completely correct in this case, is the only one that could potentially be considered for disproving the null hypothesis, signifying a non-zero correlation. (r = -0.41 , $p = 0.06$). There, however, is a quite significant problem with the data used for this assumption.

As mentioned before, there is a big outlier in the Particles group's time data which has been identifiied by using the boxplot and carefully examining the result. (Bryman, 2015) This particular participant was too far

from 1.5x the IQR from the third quartile.[1](Figure 6.7) As demonstrated in *Graphs in Statistical Analysis* (Anscombe, 1973) non-rank correlations can be especially vulnerable to outlying data, which means that in this case it would be advisable to redo the test without the outlier in it to see whether the correlation still holds. Subsequently, after performing an additional correlation with the modified data, it can be said that the low p value was most likely a false flag as the new values are r = -0.23 , p = 0.34 which are far off from the desired significance level.

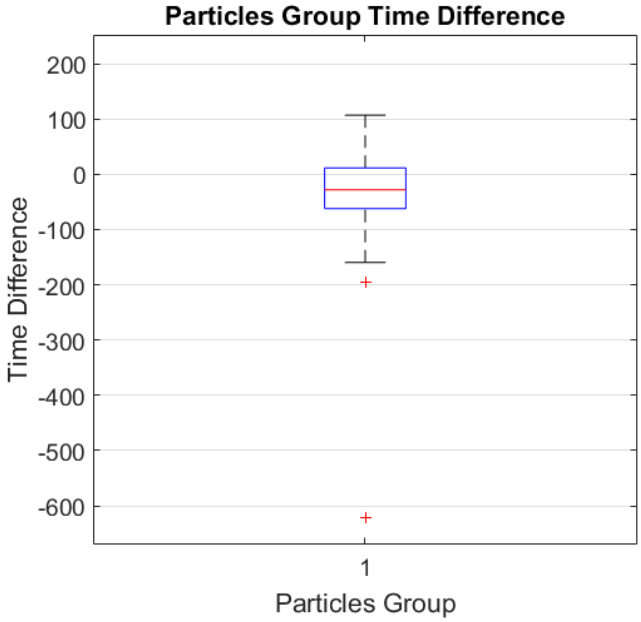

Figure 6.7: Boxplot for the particles group showing the major outlier

The point the author is trying to make is that it is desirable to review the data by graphically displaying them since the statistical results from correlation coefficients can many times be misleading. Therefore the next method applied to this data is going to be simply plotting the data and trying to fit it a first-degree polynomial using the least squares method (*Polynomial curve fitting*, 2017) to see the general trend. This data can be seen in figures 6.8, 6.9 and 6.10.

With all the data reviewed and presented, it is now time to discuss what do they mean in regards to our experiment.

6.4

[1]Interquartile Range

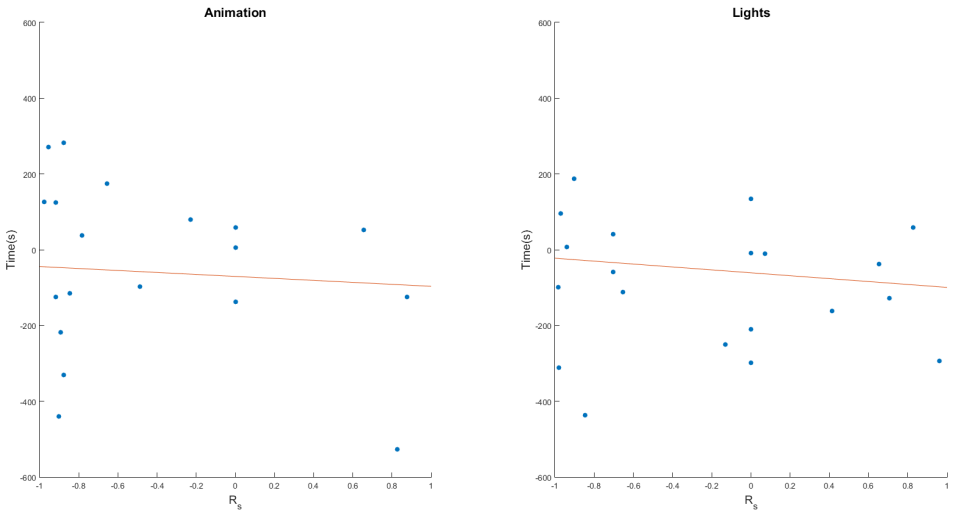

Figure 6.8: Comparison of least-squares regression result for Animations and Lights groups

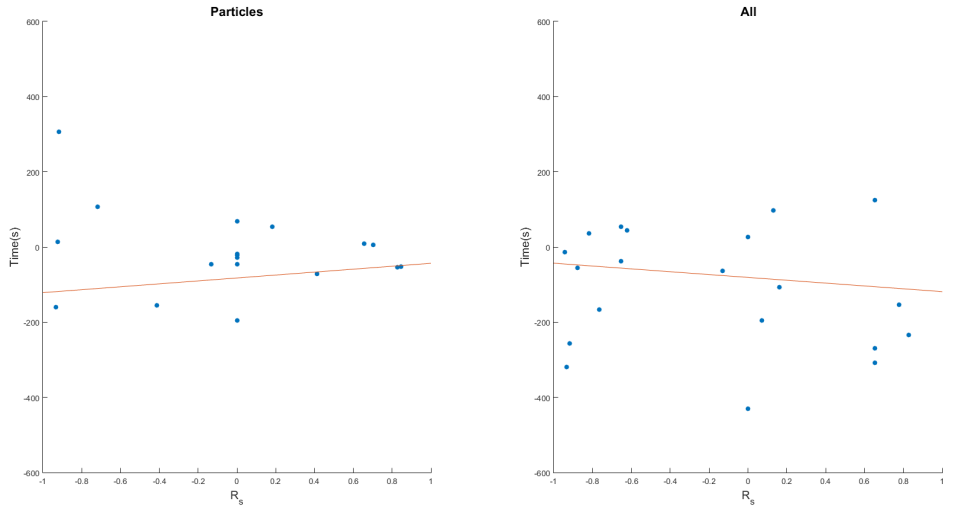

Figure 6.9: Comparison of least-squares regression result for the Particles and All Effects groups

Discussion

With the problems from the second iteration addressed, the results look much clearer as some of the unwanted impact by players not understanding the game is now gone. The fact that the game has been improved to the point where none of the players needed special guidance to finish it definitely helped them to focus on providing valid answers that tackle our research

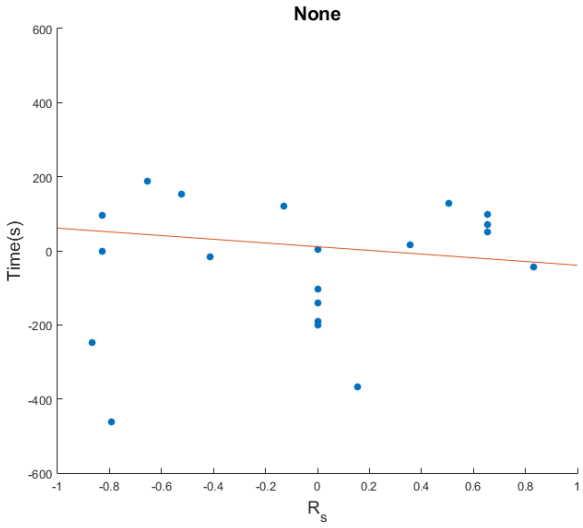

Figure 6.10: Comparison of least-squares regression result for No Effects group

question instead of being too distracted by the lower quality and issues of the game. With this being said, it still has to be mentioned that a lot of players had trouble understanding the underlying mechanics of the game which points to the fact that further development of the product would be needed to completely eliminate this issue. The help menu implemented proved very useful as it could help the struggling players understand what was necessary to do. However, a better implementation of this help menu - for example in a more interactive manner within the game (i.e. tutorial) - could potentially help fix the problem once and for all.

6.4.1 Game Results and Continuation Desire

The general results from this iteration match the results from the previous one in the sense that the particles group seems to be the one with the best results. It is important to discuss what is considered a "good" result in this case. The problem of participants not properly understanding the mechanics of the game is still plaguing the results, however it has been equally present in all five tested groups. We can therefore assume that the impact it has on the participant is the same across the groups, introducing some degree of decrease in continuation desire. This would explain the generally negative results in figure 6.6. The interesting thing to observe is then which group shows the slowest decline. In this case the Particles group comes out on top with a zero average correlation, while other groups display a mostly negative relationship.

Another very peculiar dataset is the time data as there are some contradictory results across the board. Looking at the potential correlations in table 6.4 we see - although not statistically significant - pointers towards mostly negative relations with the particles group again being the only one close to significant, however showing a more negative correlation than expected from the previous results. With the particles group scoring the best/second best in the time difference table 6.3 one could think that the particles / no effects players would get more engrossed in the game and therefore want to continue more. Then the expected correlation would be a positive relationship - in other words the shorter time compared to the real time would a player guess, the more engrossed he would be in the game, positively impacting continuation desire. Unfortunately the exact opposite is the case and it would seem like the shorter time participants guessed the more negative their continuation desire coefficient would be.

To make things even more interesting, when plotted in figure **??** the data shows again an exact opposite of the correlation table discussed above for the particles group. Here it is observable that the general trend line obtained through the means of regression analysis points towards a shorter time guessed as continuation desire increases. This happens only for the particles group, all others display a negative trend.

So far in our results it was the particles group (and to some extent the no effects group) that displayed different behaviour compared to the other tested groups. This is very important to the original research question of whether there is a difference between the different juiciness effects groups.

In the following sections these in-game results are going to be compared with the answers from the questionnaire to hopefully shed more light on the situation surrounding the test groups.

6.4.2 Data Comparisons

Now that data from both the questionnaire and the game was presented, it is possible to look back and see if there is a possible overlap in the results that could point towards the way of answering the research question.

One thing that has been apparent throughout this iteration is the standout performance of in particular the particles group and subsequently the no effects group consistently standing out from the rest and providing different results. These results were pointing to the direction that particles as visual effects provide positive impact on continuation desire, however the reason why has to be discussed further. Another question that arises is the performance of the no effects group that has been also scoring quite well compared to the lights, animations and all effects groups.

A key word in these results is consistency. The results have mostly been consistent across different ways of obtaining them - e.g. data from the in-game questions about continuation desire coincide with the automatically measured time data and those coincide with the answers from the post-game questionnaire. This provides a solid platform for further discussions about the matter and in the end a possible answer to the research question.

7

Discussion

With three iterations of the game created and tested it is time to look at all the results and try to answer the original question asked in Chapter 2. To summarize, the question in play is: *"Is there a difference between different groups of juiciness effects?"*. Based on this question, a null and alternative hypothesis have been established. These are as follows

"H_0: There is no difference between different visual effects' impact on continuation desire."

"H_1: There is a significant difference between the impacts of different visual effects on continuation desire."

Three tests have been conducted on a total of 182 participants (22, 60, 100) with the first test being focused on the usability and development of the product and the second and third on the actual research question. The division of the work into separate iterations proved very useful in a sense that a number of errors in the design were revealed every iteration and could be fixed until the next. This had an actual impact on the results.

The results from the second iteration were statistically very inconclusive in a sense that tests failed to confirm the presence of any difference between the groups. However from the participants answers and general observations is started to seem like the particles group was actually performing better then the remaining two. With that being said, the major concerns were the quality of the other two effects - one of the things improved for the third iteration - and the lack of any control group which could indicate whether there is actually a difference between individual effects and no/all effects.

With this in mind the third iteration proved way better in displaying the inter-group relationships as the issues from before that could possibly have unwanted impact on the players have been resolved. Even though the performance of the particles group has once again become apparent, a number of questions have been raised as a result of the data analysis. In the following sections these questions will be addressed and analysed more in-depth.

Why did the no effects group score relatively high?

One of the biggest question was the unforeseen success of the no effects group. Originally put in as a control group with the intention to show low scores as early research pointed to the fact that having visual effects should have positive impact on continuation desire as mentioned in Schønau-Fog and Bjørner (2012), the group scored very high, only consistently beaten by the particles group. There are several possibilities as to why is this happening. It is possible that in general the visuals of the game might have been very nice on their own and therefore people in general give it a high score. Another possibility could be lower quality of some of the effects used which made the participants more irritated than actually seeing them. Ultimately, players could just prefer less cluttered game feel.

Why did the all effects group score poorly?

The original assumption for the all effects group was that is is going to score fairly well, either on par with the individual effect groups or slightly better. Contrary to the expectations, it flopped completely in the time comparison, ending last in both mean and median value as well as placed in the lower end of the spectrum in the other comparisons. The theory is that all the effects otherwise used individually do not work as well together as they do alone. This could create a potentially overwhelming and off-putting feeling for the player as the game could be very much full of unwanted visual effects (similar to Kalyuga et al. (1999)). Unfortunately, none of the participants commented on this fact, therefore it is only a speculation.

What is the conclusion on the contradicting data for the particles group?

Although the particles group consistently performs better than the others, some of the data is very contradictory to the results. With the group having one of lowest mean time difference values the expectation is that the players were more "in the zone" when playing the game (as described by Csikszentmihalyi (1990)) which would result in higher enjoyment and continuation desire. Unfortunately, the correlation between time and continuation desire showed exactly the opposite relation - a slight negative relation (note: p values were the lowest, but still above significance level). When plotted with a regression polynomial it again showed a positive trend within the values (even without the outlying value), which once more adheres to the original hypothesis. The conclusion here is that the visual representation is the one being considered as valid, purely on the fact that the statistical

tests' p value was too high and because of scholars such as Anscombe (1973) arguing strongly in favor of always examining data visually.

How much did the product have impact on the results

The product itself definitely had impact on some of the results during the testing and especially in the second iteration that proved fairly problematic as some of the biases seemed to overpower the participants in a sense that they were more focused on the problems in the game than the game itself. This has been partially eliminated with the improvements done between the iterations, however one cannot say that they were gone completely. It can be concluded here that the situation has gotten better to the point where meaningful test results could be obtained. Having an additional iteration could definitely be favorable.

Would a broader Likert scale range have had an influence on the visual data?

In our experiment we used a Likert scale from 1 to 7, where we asked them if they liked the visual effects in the game. Our greatest problem regarding our experimental data was that most participants either rated it 5 or 6, the good point is that it was a positive score, however we did not have a great difference in the numbers and it could be argued that it would be better to have a rating from 1 to 11, to see if there was a more visible difference in the responses.

Can it be said that the results are significant?

Since the research question is asking about a significant difference between the groups it is necessary to look at all the results and see if there is an actual significant difference happening. Throughout the research the significance level has been set at the standard 5%. According to this, none of the statistical tests returned a positive result. However before the results are dismissed based on this, it is important to take into consideration several factors.

One of the factors that challenges the idea of insignificance is the consistency of some of the results - namely the particles group. The fact that it performed consistently better than the other groups across two iterations and multiple tests from different data trying to answer the same question makes it look like that it is not just a coincidence but in fact an actual result. With the results' clarity improving across the iterations, it could be

argued that (as mentioned above) there could potentially be a statistical significance if all issues of the game were completely resolved.

8

Conclusion

After several iterations it is time to conclude and see to what extent has the research question been answered. As it stands now the results are somewhere between the null hypothesis and the alternative hypothesis. (*See section* 2.8) In this moment we cannot conclude that there is statistically significant difference between the groups. However what we can conclude on is that there are signs of differences between the groups. In particular, the particles group appears to provide higher degree of continuation desire to the players than other groups and also it allowed for time estimates more in line with the flow theory for higher engrossment supporting claims made by Wei et al. (2015) and Csikszentmihalyi (1990). (Which should result in higher continuation desire.)

Originally the idea was to rank the different types of effects, but right now the data does not provide sufficient proof to decide the complete order of all items besides the winning particles group. The clarity of the data has been increasing across the iteration which suggest an additional version of the game could be necessary to be able to establish a statistically significant result.

All results have been created on a game made specifically for this experiment, therefore we cannot conclude that the results are valid for all puzzle games. It would be interesting to repeat the experiment on modified versions of existing games.

This research presents new perspective on juiciness effects in continuation desire as it goes deeper into the impact of individual effects. We imagine this research could be useful for game developers and game researchers when designing for higher continuation desire.

9

Future Work

9.0.1 Further Work Regarding Our Game

If continuing on our project and developing it further to a game, it would be very interesting to look at the experiments responses. We should study the responses more and find a solution on how we can improve the game mechanics and find out exactly which points the player understood and which points they did not understand. By finding these answers regarding the game mechanics we can develop a tutorial where the players get explained the game mechanics. It seemed that many players needed this tutorial in order to completely understand the concept and context of our game.

Many participants said in their answers they wanted more interactions. In further prospects we could develop these interactions. While developing our game we had to eliminate many game elements because of time schedule, however it is interesting to see that the participants suggest to implement some of the elements which we wanted to develop as well. Some of these elements were game elements which would fit the theme of the game like humans cutting down the forest, adding a brush wall which would protect better from humans and make it harder for them to cut through the forest. Furthermore we also wished to add a volcano which could explode, destroying trees as well as humans but also make it easier / faster to grow trees there after the explosion because of the nutrition in the earth.

Other elements could be that it is possible to add nutrition individually to every tile and other gaming elements which would make the trees easier to grow.

These elements would be elements that would be very interesting to implement if we had more time to game development and should continue our work on this project.

9.0.2 Academically

In this master thesis we had time to develop a project and report with statistical data and iterate upon it to improve it as best as we could, however if more time was available or if we could research further as PhD students we would like to go more in depth with juiciness effects and visual effects

in games, since this seems like a very sparsely investigated area in the field of game research. This study research the effects of juiciness effects on a number puzzle game, it would be interesting to research this number puzzle game area further and create different games to see if the same results would be present or other effects would be more important for the players.

Other game types and other game genres like card games, puzzles or other formats could also be very interesting too see how much the particle effects and other juiciness effects have in relation to continuation desire.

In relation to our results regarding the juiciness effects we had some large testing groups when developing our experiment on second iteration and third iteration, we had a total of three groups in both iterations with a total of 40 in each, this means we had data collection from a total of 120. In our last experiment we also had the testing group with all juiciness effects and with zero juiciness effects this results was very similar, and we tested on a total of 40 with 20 in each group. Both groups seemed positive regarding the visual elements however it could be interesting to increase this test group, to see if the numbers just was mere coincidence or if the numbers shows us that there is a very small difference in continuation desire with all effects and no effects. Our study does not show us if our effects actually are not good or if all the effects together are to much and therefore does not do any difference, it would be interesting too test these variables again too see if there is a difference, either with all effects and no effects.

However in this study we can confirm after testing 180 participants that particles are in a prime position to become the best, but many answers like too see if this is the case regarding other game types is still unresolved, and it would be interesting to work further with these prospect within the field of game studies.

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10

Appendix

10.1 Files And Resources

Media technology production, A/V production and in game data can be found on Google drive under following link:

https://drive.google.com/drive/folders/0BzzhQJXSJhM6TGJhMHlLbktFZnc?usp=sharing

10.2 Before and After the Experience Questionnaire

Before the Experience - Forest Game

Forest Game - third iteration

*Required

Participant Number *

Your answer

Gender *

- Male
- Female

Age *

Your answer

How long do you play video games each week (average) *

- 0 (Never)
- 1-4 Hours
- 5-10 Hours
- 11-19 Hours
- 20-30 Hours
- 30+ Hours

What is your favorite game /genre?

Your answer

Please indicate below the extent to which you agree or disagree with this sentence: “I want to begin the experience” *

	1	2	3	4	5	6	7	
Strongly diagree	○	○	○	○	○	○	○	Agree Strongly

What makes you want/not want to begin?

Your answer

Now you are ready to start the game. Press submit and wait for the test conductor.

After the Experience - Forest World

Third Iteration

*Required

Participant Number *

Your answer

Please indicate the extent to which you agree or disagree with this sentence: “I want to try again!” *

	1	2	3	4	5	6	7	
Strongly diagree	○	○	○	○	○	○	○	Agree Strongly

What makes you want/not want to try again? *

Your answer

“What do you feel now?” *

Your answer

“What did you just experience?” *

Your answer

Why do you want/not want to try again? *

Your answer

General comments concerning the experience?

Your answer

How many minutes do you think you have spent in the experience? *

Your answer

"I like the visual effects in the game" *

	1	2	3	4	5	6	7	
Strongly disagree	○	○	○	○	○	○	○	Agree strongly

What did you think about the visual effects in the game? *

Your answer

Do you want to enter a competition for steam keys? If so, please put down your email here.

Your answer

Any Last comments?

Your answer

Thank you for your time!

SUBMIT

Never submit passwords through Google Forms.