DESIGNING A FRAMEWORK FOR VR MECHANICS THAT ELICIT TARGETED EMOTIONS

A Thesis Submitted for the Degree of Doctor of Philosophy

By

Adriana Leigh Mallary

Department of Arts & Humanities,
Brunel University London

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Abstract

The realm of Virtual Reality (VR) in game development is rapidly expanding, paralleled by a growing interest in designing emotionally resonant VR experiences. However, there exists a notable void in design frameworks tailored for crafting mechanics that precisely evoke intended emotions. This thesis aims to bridge this gap by formulating a comprehensive framework that aids developers to create VR game mechanics that elicit targeted emotional responses. Starting with an immersive study of various VR games, this project analyses existing VR mechanics and their emotional impacts. These insights contribute to the development of initial models, tested before forming an initial framework, and further validated through a Pilot Study. Subsequently, the viability of the framework as a practical tool for designers is substantiated via the creation and assessment of two VR prototypes, each aimed at eliciting divergent emotional states. The main study, involving participant feedback, refines the framework's efficacy and identifies necessary adjustments. The culminating outcome of this comprehensive journey is the delivery of a refined and validated framework, suitable to support developers in the gaming industry to craft emotionally engaging VR experiences.

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Table of Contents

Table of Figures

Chapter 1: Introduction

1.1 Background and Research Problem Statement

The Virtual Reality (VR) market has been growing exponentially in the past few years, with media such as *Ready Player One* (2018) showcasing the transformative potential of VR on both games and everyday life. Research involving VR has been around for more than 25 years, with "1000s of papers and many researchers in the field, comprising a strong, interdisciplinary community"; however, there are still new topics and research areas emerging year by year (Cipresso et al., 2018). VR itself provides potential for greater immersive experiences that cannot be found in other mediums. As Chris Busse, the head of Skydance Interactive said, "The sensory experience of VR is so much more potent" (Vive, 2020). Having developed and published *The Walking Dead: Saints & Sinners* (Skydance Interactive, 2020), Chris identified this potency as "helping to enhance their horror elements with greater immersion".

The advances in the VR industry have provided significant benefits to a wide-reaching audience, from medical organisations, educational institutions, or the military, to its more traditional route as a platform for video games. However, "despite the numerous potential applications of VR, much of the commercially available content is games" (Hvass, Larsen, Vendelbo, Nilsson, Nordahl, and Serafin, 2017). Within the gaming market, VR is poised for significant growth in the upcoming years, building on its already impressive trajectory in recent times – this can be seen in **Figure 1** (Mordor Intelligence Research & Advisory, 2022).

VR MARKET IN THE GAMING INDUSTRY

Figure 1: VR in Gaming Market Overview (Mordor Intelligence Research & Advisory, 2022)

In the realm of these diverse experiences and the ongoing development of games for this distinctive medium, essential questions arise concerning the appropriate design approaches. Given the transformative potential of VR, developers must grasp the intricate interactivity inherent to this platform (Jing, 2021). The mechanics in VR markedly differ from those of traditional gaming platforms like PCs or consoles. Instead of clicks or button presses, VR controls infuse physicality into interactions, aiming to envelop players entirely within the virtual realm. VR design introduces novel considerations of physicality and spatial orientation, alongside the potential for heightened psychological and physiological reactions (Desurvire and Kreminski, 2018).

The creation of a successful and impactful VR game necessitates meticulous attention to design, given the unique challenges of interaction, psychology, and ergonomics intrinsic to this medium. While previous studies have explored VR design through various methodologies, such as formulating guidelines or employing approaches that specifically address embodied interactions like embodied cognition (Desurvire and Kreminski, 2018; Soler, Contero, and Alcañiz, 2017), there remains a noticeable gap in design focused on players' emotions. This gap is not limited to VR games alone but is evident within the broader realm of games design.

According to Desmet, "emotions have played little formal role in the design profession" (2002, p.3). This lack of emphasis on emotions is also echoed within engineering and disciplines like human-computer interaction and cognitive ergonomics (Desmet, 2002, p.3). The deficiency is particularly pronounced when designing VR experiences that deliberately aim to elicit specific emotional responses. This thesis takes a multidisciplinary approach, drawing not only from games design but also from psychology, with a specific focus on emotions and the metrics used to quantify emotional reactions. The novelty lies in the absence of established design principles for emotional engagement, both in the context of VR and, more broadly, games design. Further research in this area has the potential to mutually enrich both emotion research and game design methodologies.

The mechanics and dynamics of a game hold the power to evoke shifts in players' emotional states. Game designers have long grappled with infusing emotions into their creations. Take, for instance, Sylvester's *Guide to Engineering Experiences*, where he breaks down the process of crafting emotionally resonant experiences through a combination of mechanics, narrative, and fictional immersion (2013). In their pursuit of crafting immersive experiences, game designers engineer designs aimed at evoking emotional responses from players. As a result, we can analyse these emotional responses by examining the different emotional states players experience throughout gameplay.

These emotional states encompass a wide spectrum of feelings, including “engagement, fear and stress, frustration, and anticipation”, as well as cognitive states like “challenge” (Yannakakis and Paiva, 2014). These resultant shifts in the player’s emotional experience become pivotal components of the design process, significantly shaping the player’s engagement. The ability to finely tune these emotions hinges on a game’s genre, narrative, objectives, and overarching gameplay mechanics (Yannakakis and Paiva, 2014). Furthermore, this approach accelerates and optimizes game development, streamlining the entire process.

Building upon the understanding of how game mechanics intertwine with emotions, Rachitsky and Beharry (2019) highlighted key aspects during their insightful presentation on emotions in VR at Oculus Connect 6, a conference dedicated to all things VR hosted by Oculus. Rachitsky and Beharry’s discourse unveils three fundamental areas, with memorability taking the lead. This concept underscores the tendency for users to vividly remember emotionally charged experiences and moments. Their subsequent point delves into the concept of *presence*, a widely recognized term within the field of game design academia. Presence encapsulates the psychological perception of a seamless connection between the player and the experience, creating the illusion of being fully immersed in the game world (Lombard and Ditton, 1997). This sense of presence hinges upon the player’s emotional immersion, with heightened emotional engagement translating to a more potent sense of being present within the virtual environment (Rachitsky and Beharry, 2019).

Among the final points emphasized is the connection between emotions and player motivations. As Rachitsky (2019) asserts, "Since emotions tell our bodies what to do, they also motivate our audiences." This connection manifests prominently in games, where the level of challenge escalates in tandem with the player’s desire to engage. By effectively balancing these two elements, games can usher players into a state of *flow* (Csikszentmihályi, 1990), a state characterized by complete immersion where players lose track of time and engage effortlessly.

1.2 Research Motivation

Drawing from my experience crafting a VR heritage site during my Master’s (Mallary, 2020), I was compelled to delve deeper into the realm of VR game design. A comprehensive literature review revealed a gap with the role of player emotions in VR game design. Driven by a curiosity about the deliberate elicitation of emotions in VR experiences, my objective evolved. I aimed not just to bridge this gap, but to construct an adaptable framework tailored to the intricacies of emotion-centric VR game design.

Initially interested by the potential mental health benefits of VR, particularly in alleviating depression and anxiety, my pursuit then transitioned into exploring the broader spectrum of emotional responses in virtual environments. My ambition pivoted towards developing a holistic framework capable of addressing a wide array of emotions within players. Determined to validate its viability, I chose a hands-on approach with research by design. I decided to craft two distinct game prototypes to put the framework to the test, focusing on calming and tense emotional states (partially inspired by the initial goals with mental health as a focus). Subsequent play-testing sessions served as a pragmatic validation step, affirming the framework's practical efficacy.

1.3 Research Question, Aim, and Objectives

The overall aim of this thesis is to create a framework for designing VR mechanics that elicit targeted emotions. The present research of this project contributes to the academic body of VR research by investigating the applications of emotional design to a VR environment, where the nature of mechanics in the game are inherently different than other mediums.

By developing this framework, the current project aims to explore the emotional affect of different types of mechanics in VR games. In other words, this thesis investigates emotional design processes in VR games and creates a functional framework that can be utilized for designers to: 1) create individual mechanics that elicit targeted emotions from players 2) create gameplay experiences stringing together multiple mechanics and thus a flow of emotional experiences and 3) evaluate existing games to understand the emotions elicited through each mechanic.

The research question: *"How can we design mechanics that elicit targeted emotions in VR games?"*

Due to the subjective nature of emotions, an investigation into the effect of player types on the emotional elicitation will also be explored. The aim of this secondary goal is to be used as a supportive analysis of the developed framework's validity to apply to all player experiences.

This secondary question: *"What are the effects of player types on the emotions experienced in VR games?"*

The overall aim of this thesis will be accomplished through the following research objectives:

1. Gain an understanding of emotions by exploring the variety of definitions, theoretical frameworks, and concepts used in psychology.
2. Develop a theoretical framework for the definition of emotions to be applied to the design framework of this thesis, which will enable a method to identify and measure emotions to be produced.
3. Gain an understanding of emotional design and its applications to different mediums, alongside an understanding of game design and designing for VR.
4. Develop the initial design framework through playtesting existing VR games and conducting emotional evaluations based on the theoretical framework's understanding.
5. Empirically validate the results through a pilot study examining the similarities of emotional responses from the participants to the researcher's findings (alongside initial understanding of effect of player types)
6. Use the framework in the design of two VR prototypes, aimed to elicit specific emotions. I develop these two VR prototypes in Unity game engine. This will assess the framework's performance within a practical application scenario.
7. Empirically validate the framework through a main study consisting of participants playtesting of the two VR prototypes, understanding whether the emotional response aligned with the framework's results, and whether the player type altered results.
8. Evaluate the framework's efficiency and validity through data analysis of the study's results.
9. Contribute to the design research of VR games with a validated framework that organisations or designers can adopt as a tool to help aid their design process in order to elicit targeted emotions in their players or add onto further with their own research and development.

1.4 Research Design & Methodology

This thesis is looking at the design approach through an Affective Design lens, aiming to explore the relationship between a user and a product – or in this case, the player and the VR games' mechanics. The methodology used in this thesis is focused on Research by Design, aiming to explore design through inquiry. The designed framework will be created through playing and evaluating existing VR games, tested in the design of VR prototypes, and evaluated through the performance of the developed protypes from a study with play-testers.

The study followed a qualitative approach. Consideration was given to follow a mixed methods approach using both quantitative and qualitative for the whole scope of the project, however this was found to interrupt the accuracy of results and will be discussed further in **Chapter 3**. I chose a qualitative approach, supported by multiple data collection methods and data analysis techniques, to acquire a comprehensive understanding of the complete play experience a participant felt, and the emotions the participant personally identified with.

The study's research design has been summarized in three separate components, the initial research and theoretical basis, the framework design and pilot study, and finally the prototype development and main study.

1.4.1 Understanding the Literature and Establishing the Theoretical Basis

In the initial phase, due to the elusive nature of emotions and an appropriate definition, an extensive literature review was carried out on the concepts of emotions, analysing theoretical frameworks used to define, identify, and classify emotions to identify how the current study would frame the evaluation method of emotions for the proposed framework of this thesis. The exact model chosen for this project was the Circumplex model of affect (Russell, 1980), which pits emotions on two axis that intercept on a graph – the x axis is the valence (positive and negative), while the y axis is the arousal (excitation state).

There was also additional research carried out in the design area, focused on understanding designing for emotions and game design frameworks. A literature review was carried out to cover games design frameworks, emotional design applied to games, and emotional and affective design outside of games. When delving into emotional design, it also involves assessing the design procedures across various mediums, alongside an evaluation of synonymous terms for emotional design, such as affective design. Affective Design pertains to the realm where technology has the capability to discern, replicate, and comprehend human emotions (Picard, 2000) An additional portion was added onto this research focusing on how designing for VR is different from traditional gaming mediums. This thesis primarily focused on the MDA Framework and Norman's Emotional Design as its core conceptual frameworks (Hunicke, LeBlanc, and Zubek, 2004; Norman, 2005).

1.4.2 Phase One: Exploring VR Mechanics and Creating a Framework

With the combination of emotions and design, a base for the framework on emotional elicitation from VR mechanics began forming. In order to populate the framework and understand what required adjustments, I began playtesting existing VR games. The process involved filling out a survey to evaluate the mechanics and their corresponding emotional responses after playtesting a game.

While I personally conducted the emotional evaluation, the potential for emotional subjectivity existed, which could have rendered the outcomes ineffective if extrapolated to others. For this reason, a pilot study was conducted. The pilot study was used to both verify the emotional conclusions reached by the researcher, as well as gain an initial understanding of the player types' effects on the emotional responses. The primary data collection method was through semi-structured interviews at the end of the play session, while data analysis was done through classifications of the interview material afterwards (with references to observational analysis notes I made during the session to verify the interview comments made by participants). Thematic analysis was used with the interview responses in the Pilot Study, as the emotional evaluation was primarily done through the interviews. This was less prevalent with the more structured questionnaires being used in the main study; hence, thematic analysis was swapped over to the questionnaire responses instead. Player types was also gathered through a questionnaire of an existing player type framework called HEXAD (Tondello et al., 2016).

1.4.3 Phase Two: Using the Framework and VR Prototyping

Having verified the initial framework results through the data collection and data analysis of the pilot study, phase one of the framework's design was completed. I proceeded onto the second phase of the study – using the framework to design two separate VR prototypes to explore different emotions and understand the framework's performance when involving multiple mechanics and other interfering factors. I developed the prototypes using the Unity game engine (Unity Technologies, 2005, Version 2021.3). The emotional responses would then be verified via the main study, following a survey-based approach for the emotional analysis after each prototype playthrough.

The data collection methods for this study primarily relied on surveys after each prototype to evaluate their affective states throughout gameplay. These results were supplemented with a short interview to verify the understandings reached via the questionnaire. Results were also supported via observational analysis during play of both prototypes.

With the completion of the main study, the framework was able to be revised. The results were used to review the success of the framework's use in the design process and whether the emotions felt by the participants corresponded to the aims of the prototypes. The overall aim of the qualitative phase was to examine the validity of the framework, with a secondary goal to further explore the relationship between player types and emotional responses elicited.

1.5 Research Contribution

This project aims to understand the design of mechanics in VR games that elicit targeted emotions. As a result, the developed framework of this study examines the relationship between the two and creates a connection within the design process of the framework.

This research contributes theoretical insights in three areas: psychology, emotional design, and VR. The current study demonstrates the application of the chosen theoretical framework to a new medium, VR, and creating a better understanding of emotions in an immersive environment. The framework created as an outcome of this study also offers the opportunity for future studies to be conducted in emotional design, by providing a basis on the applications of this area to VR environments. The current study also provides insights into designing for VR, by being one of the first to create an emotional design framework explicitly for VR games design, and empirically exemplify and evaluate the effectiveness of the framework through developing VR game prototypes.

The aim of this thesis is to contribute to the current academia of design in VR experiences, focusing on emotional design and its applications specifically to VR games. By creating an initial framework that can be easily added onto and further developed, this thesis strives to create a tool that can be applied practically, aiding designers in the industry and supporting any stage of the design process – whether this be at the inception of a game idea, at the later stages of development, or even as an evaluative tool of already published games. Additionally, by understanding how the framework works, designers can further add onto and develop the framework – from expanding the emotions available in the design process, to considerations for addressing different areas of emotional subjectivity.

1.6 Scope of Research

The scope of this thesis is limited to VR games. With VR games already greatly expanding in the past few years with the growing success of the medium, VR games has been determined as an already expansive scale and scope of this thesis. The flexibility of the framework also gives the benefit of potential applicability in games of other mediums, and VR experiences in general. Due to the different nature of VR, the extension to VR experiences would be a more practical expansion with a likelihood of success.

1.6.1 Limitations

The limitations when dealing with emotions are identifiable via the subjectivity of their nature. The factors that can affect players, such as their cultural background, religion, socioeconomic status, etc. are considered out of the scope of this project.

This is primarily due to two factors: 1) to receive more accurate results, the amount of participants would need to drastically be increased, taking the focus away from receiving individualized feedback on the different emotional responses and experiences of the participants, and more on gathering all potential varying background information and 2) the timeframe of conducting such a large scale study would not be possible.

Additionally, the smaller number of participants creates difficulties for generalization. With a limited dataset to reference, the exact accuracy of the framework cannot be fully verified. The exact effect of player types is also focused on hypothesizing the relationship to the framework, due to the limited subset of player types in participants, as well as their gaming backgrounds. Without many participants from outside the Game Design degrees at Brunel, the data could potentially have a small skew due to participants' familiarity with games. However, the advantages of involving students from Games Design arguably surpass this limitation. The potential to design for both future game designers and persistent gamers ensures that the studies will encompass both the intended users of the framework and the framework itself.

1.6.2 Delimitations

Regarding the subjectivity of emotions, it should be highlighted that the studies in this thesis have adopted a validation method in an attempt to investigate the range of emotions based on different play approaches. By understanding the player types each participant self-identified as, there is the secondary research question to tackle some of the emotional subjectivity that could potentially disrupt the framework and design process. Due to the scale of this project, only player types will be considered as a factor that can affect the emotional response of a player.

Whilst there is the potential effect of only having students from a gaming background, this was in part chosen due to their familiarity with gaming consoles and easier adaptation to VR. While there were participants who had zero familiarity with VR, because of their comfort with other games, I was not held up in the testing time extensively to explain how to use the controllers and adjust the headset. Additionally, explaining basic actions such as teleportation were more easily understood. Also, because the framework of this project is geared towards being used in a gaming context, and with the inclusion of users who had not used VR, the result of this decision felt negligible in its potential to skew results.

1.7 Structure of Thesis

The structure of this thesis will be divided into 8 chapters, as seen in **Figure 2**. A brief description of each chapter's contents and discussion points have been summarized below:

Chapter 2 – Literature Review: This chapter forms the foundation for framework development, explaining how emotions are identified and defined, and their integration into design processes. It also surveys VR research, design frameworks, and applications in academia and industry. It starts by outlining game design and emotional frameworks, then delves into emotional and affective design in various domains, including product design. Next, it explores VR specifics before addressing emotions. This emotion section establishes the theoretical groundwork by examining psychological research on defining, conceptualizing, measuring, and comprehending emotions.

Chapter 3 – Methodology: introduces the theorical basis of the thesis, the research design, methodology, and methods that are used in this study. This chapter presents the justification for using a qualitative research approach, alongside justifications for the selected data collection methods and data analysis techniques.

Chapter 4 – Framework Exploration: breaks down the design process of the framework and the initial models created, examples of initial application, and the evolution of the model. Additionally, this chapter introduces the design process and evaluation process of this framework.

Chapter 5 – Design of Prototypes: explores the practical application of the framework to the design process of two separate VR prototypes, focusing on eliciting two separate emotional states: calm and tense. This chapter also encompasses a breakdown of how each prototype is played, offering insights into a typical playthrough of them.

Chapter 6 – Pilot Study Results & Discussion: presents the data and findings, accompanied by visualisations to help showcase the trends. This chapter discusses the findings and results in relation to the conceptual framework of this project and discusses revisions that were made following the study. It also addresses player types and how/if this altered the results is also introduced and evaluated.

Chapter 7 – Main Study Results & Discussion: provides the data and findings of both prototypes separately, again with visualisations to help identify trends. This chapter discusses the findings and results in relation to the conceptual framework, evaluating its performance and potential further revisions. It also addresses player types and reaches a conclusion to keep player types separate from the framework for this thesis.

Chapter 8 – Conclusion: presents the final conceptual framework developed from this project. The chapter also discusses the significance of the present research by defining the theoretical and practical contributions, alongside the limitations of the current study and potential further research directions.

Chapter 1

- Introduction and motivation of the research

Chapter 2

- Literature review of games design frameworks, emotional design applied to games, emotional and affective design, and designing for VR
- Literature review of eliciting, identifying, and measuring emotions

Chapter 3

- Basis of theoretical framework for emotions, research design, methodology, and data collection methods

Chapter 4

- The design process of creating the framework (Phase 1 = Identifying Emotions, Phase 2 = Evaluating Emotions)

Chapter 5

- The design process of creating the prototypes using the framework

Chapter 6

- Data and Results of the Pilot Study
- Critical analysis and discussion of the Pilot Study, revision of framework from fiindings

Chapter 7

- Data and Results of the Main Study
- Critical analysis and discussion of the Main Study with an evaluation of the framework - revisions, performance, and further feedback

Chapter 8

- Research Overview, Contributions, limitations, and further research directions

Figure 2: Structure of Thesis with Chapter Summaries

Chapter 2: Literature Review

2.1 Introduction

In order to address the research questions of this thesis, familiarity with research areas both inside and outside game design need to be developed. The scope of these research areas includes:

- Game Design (Frameworks and emotional design applied to games)
- Designing with emotions outside of games (*e.g.* Affective Design, Emotional Design)
- Designing for VR (physicality and presence, heuristics)
- Defining emotions and theoretical frameworks

The research discussed is built on literature findings taken from multiple disciplines around the core areas of this thesis: emotions and design. The literature on design is taken from games design frameworks and emotional design applied to games, design methods with emotions outside of games design (Emotional Design and Affective Design), and design considerations for VR from both academia and industry experts. The theoretical concepts of emotions are drawn from psychology.

To proceed through this thesis, the initial section on Game Design seeks to address what a framework involves, alongside illustrative examples of design frameworks within the realm of games academia. Subsequent sections will introduce design methodologies, both within and beyond the industry. It's pivotal to recognize that designing for VR necessitates unique considerations due to its immersive nature, therefore the next section will address the different design considerations of this medium. Lastly, this chapter will delve into the nuanced aspects of defining, evoking, and quantifying emotions.

2.2 Frameworks for Game Design

Throughout the existence of games, both researchers and industry professionals have attempted to improve our understanding of game design principles. This growth has brought with it a rise in frameworks being created over the years, both for use in industry and academia. A number of these creations have grown in popularity with their practice; however, there is limited discourse attempting to formally define their definitions and terminology.

In the games industry, the process of designing or creating a game does not adhere to a standardized approach that is universally followed by game designers. The primary influence on the design process is often more practical, with factors such as time constraints or financial budgeting. Other such problems particularly in the game design area included examples such as: “Feature Creep”, “unrealistic scopes”, “design problems”, among others (Politowski et al., 2021).

However, that does not mean frameworks have not been created for the design process of games. In order to understand how to create a design framework, it is important to address pre-existing ones. In the next few subsections, my objective was to address the goals of each framework and ascertain their suitability for adaptation to the objectives of this thesis.

2.2.1 Existing Frameworks

Frameworks are quite varied in their design with little standardization between their approaches and definitions. While Schell believes the need for strict definitions is not necessary, he still discusses the need for a standardised vocabulary (2015). The confusion with frameworks in game design often comes with considering the origin and background of the framework, as well as the category it belongs in. How can we make distinctions between a game design framework, or when theories from other areas, such as psychology, are applied within a game design context?

This thesis considers frameworks as a set of concepts to assist the design process and provide perspective to an area of interest in games design. A list of existing frameworks in game design would be too expansive for the scope of this chapter, therefore the more known and popularly practised frameworks will be briefly introduced and discussed.

2.2.1.1 Bartle Taxonomy

In the pursuit of comprehending players’ motivations during gameplay and their preferences across various genres, researchers have sought to classify different player types. Among the earliest endeavours in this direction is Bartle’s (1996) typology, which categorizes players into four distinct types - socializers, killers, achievers, and explorers - primarily in the context of Multi-User Dungeons (MUDs). While newer categorizations have emerged, Bartle’s typology remains a popular reference point for designers due to its straightforward approach to understanding player motivations.

These four player types can be defined as follows:

- Socializers: Players who derive enjoyment from social interactions and communication with fellow players.

- Killers: Players who revel in creating chaos and disrupting the experiences of other players.
- Achievers: Players who find satisfaction in attaining in-game goals or self-defined objectives.
- Explorers: Players who relish the act of uncovering and exploring all aspects of a virtual world.

Bartle's model organises these player types along a graph, with axes representing the source of players' interest. The two axis, visually depicted in **Figure 3**, showcase a scale between world-oriented vs player-oriented (x-axis), and acting on vs interacting with (y-axis (1996). This graphical representation allows mapping players' motivations onto specific coordinates corresponding to these player types. It's worth noting that players' positions on this classification aren't fixed; they can shift based on factors like mood, playstyle, and other contextual elements (Bartle, 1996).

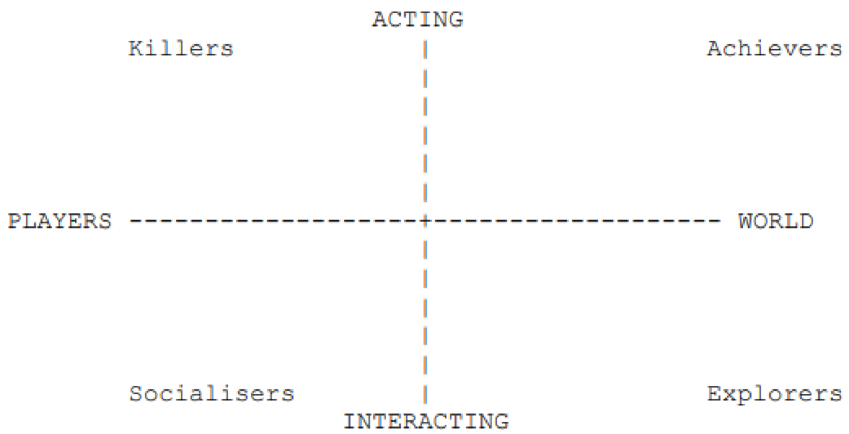


Figure 3 A Graph of Bartle's Taxonomy with Player Types Mapped to Four Quadrants (1996)

Because this thesis will be exploring player types as a secondary research question, other frameworks and methodologies of understanding player typologies will be covered in this subsection.

Others have added onto Bartle's use through examples such as Yee's factor analysis approach (Yee, 2006; Yee, Ducheneaut, and Nelson, 2012). This approach, based on Bartle's player types, led to the identification of three primary components of player motivations and ten sub-components. These are achievement (advancement, mechanics, and competition), social (socializing, relationship, and teamwork), and immersion (discovery, role-playing, customization, and escapism) as outlined by Yee (2006).

However, like Bartle's model, Yee's classifications also have a focus towards one specific game genre – Massively Multiplayer Online Role-Playing Games (MMORPGs) (Tondello et al., 2016). Both Bartle and Yee's models were not created for an all-inclusive range of game genres, but are often applied to all game genres. Another important note regarding the previous models – most of them were developed specifically for game design, rather than gameful design. To consider the flexibility of this framework and its potential alternative applications to VR experiences, rather than games, this thesis has decided to go with a framework geared more towards gameful design.

Bartle's classification of player types wasn't the sole attempt at categorization. Additional studies have sought different avenues of correlation, some focusing on the interplay between personality traits and player inclinations. For instance, a study employed the Player Experience of Need Satisfaction (PENS) metric to delve into both player personality and gaming encounters, ultimately identifying a link between the two factors (Johnson and Gardner, 2010).

Other such models aimed to connect motivations to the Myers-Briggs Type Indicator, or MBTI (Myers, 1962). An example is the Demographic Game Design model by Bateman and Boon (Bateman and Boon, 2005), which introduced player styles: Conqueror, Manager, Wanderer, and Participant. Another iteration of the model built upon the initial framework by considering additional factors like the interplay between hardcore and casual gaming, the skill sets associated with teaching, and preferences for single-player versus multiplayer experiences (Bateman, Lowenhaupt, and Nacke, 2011).

While both these models offer insights into player motivations and characteristics, it's important to note that they both draw on the MBTI psychometric model, rather than being explicitly centred around gaming. Moreover, concerns have arisen regarding their methodology and data collection methods (Tondello et al., 2016). Furthermore, the MBTI itself lacks robust empirical backing and reliability within the realm of psychology. Its limited theoretical foundation, inconsistent test-retest reliability, and simplified binary categorizations overlook the complexities of human behavior. For these reasons, the MBTI will not find application in this thesis.

Another model called the BrainHex model, developed by Bateman and Nacke, introduces seven player types: Achiever, Conqueror, Daredevil, Mastermind, Seeker, Socialiser, and Survivor (Nacke, Bateman, and Mandryk, 2011; Nacke, Bateman, and Mandryk, 2014). However, this model was made not just with considerations towards previous player typologies, but also with neurobiological research. With this mixed approach, a more diverse array of player archetypes was addressed. It has also been employed in several studies so far within Human-Computer Interactions (HCI) (Birk, Toker, Mandryk, and Conati, 2015; Orji, Vassileva, and Mandryk, 2014).

However, my aim was to create consistency with the psychological background that underlies my theoretical framework when choosing the player types framework. For this thesis, because the neurobiological background for defining and measuring emotions was discarded in favour of other approaches, this framework was determined to not fit within the theoretical basis of this project. Furthermore, the previous framework's reliance on the MBTI was deemed to lack sufficient grounding in psychological research to establish its accuracy.

There are also models that are broader to be applicable to gamification in areas that are not video games (Tondello et al, 2016). Having been created recently and based upon more up-to-date research, the HEXAD framework provides a survey measure to identify user preferences toward game elements. This framework has been validated as reliable through studies (Tondello et al., 2019; Krath and von Korflesch, 2021).

This model's theoretical foundation is based on the principles of the Self-Determination Theory (SDT), which delves into both intrinsic and extrinsic motivating factors. SDT stands as a psychological framework that revolves around human motivation, contentment, and the satisfaction of fundamental needs. This encompasses three primary intrinsic needs: Autonomy (the ability to act with agency), Competence (the pursuit of mastery), and Relatedness (the requirement for interpersonal connections) (O'Shea and Freeman, 2019). Consequently, the Hexad user types are representations of these distinctive motivational facets (Tondello et al., 2016).

The Hexad model seeks to encompass a wide spectrum of gameful systems, aiming for versatility in its application across various domains such as gameful systems, games, and gamification. Within this model, six distinct player types are proposed, each tailored to align with either intrinsic or extrinsic motivational factors (Tondello et al., 2016). As stated by Tondello and colleagues (2016), the Hexad user types directly represent these discernible motivational factors. The study's findings also establish connections with the 'Big Five' personality traits, reinforcing the interrelation between individual personalities and gaming preferences (John and Srivastava, 1999). Anchored in the Self-Determination Theory (SDT), the model's theoretical foundation delves into the interplay of intrinsic and extrinsic motivations. Importantly, the intrinsic motivation types within the model are rooted in the principles of SDT (Tondello et al., 2016).

In this thesis, the choice was made to employ the Hexad model due to its integration of the SDT model, which encompasses intrinsic and extrinsic motivations. This decision aimed to address the issue of emotional subjectivity by incorporating another dimension that varies from person to person yet can still exhibit overlaps. Consequently, This would mean that if we identify similar motivations between players that may be different in terms of demographics, there is still the potential for the framework design to elicit similar emotions. Therefore, the examination of player typologies in this study acts as supplementary support to assess whether this framework can incorporate such considerations and determine if any alterations in mechanics can be quantified. However, it's essential to recognize that existing frameworks require further exploration to establish foundational points for the design of this thesis framework.

2.2.1.2 Engines of Play

The initial ideas of "Engines of Play" can be attributed to the presentation by VandenBerghe at GDC 2012 called "The 5 Domains of Play: Applying Psychology's Big 5 Motivation Domains to Games" (2012). As its name alludes to, the framework's base is tied to the Five Factor Model of Personality, also referred to as the "Big 5", and is comprised of multiple components, or "engines". This includes Taste Maps, The Consumers Journey, and Motivation and Satisfaction (using SDT). When designers are evaluating a game, they are advised to describe the depth of the potential experiences players can engage with via Taste Maps (VandenBerghe, 2014).

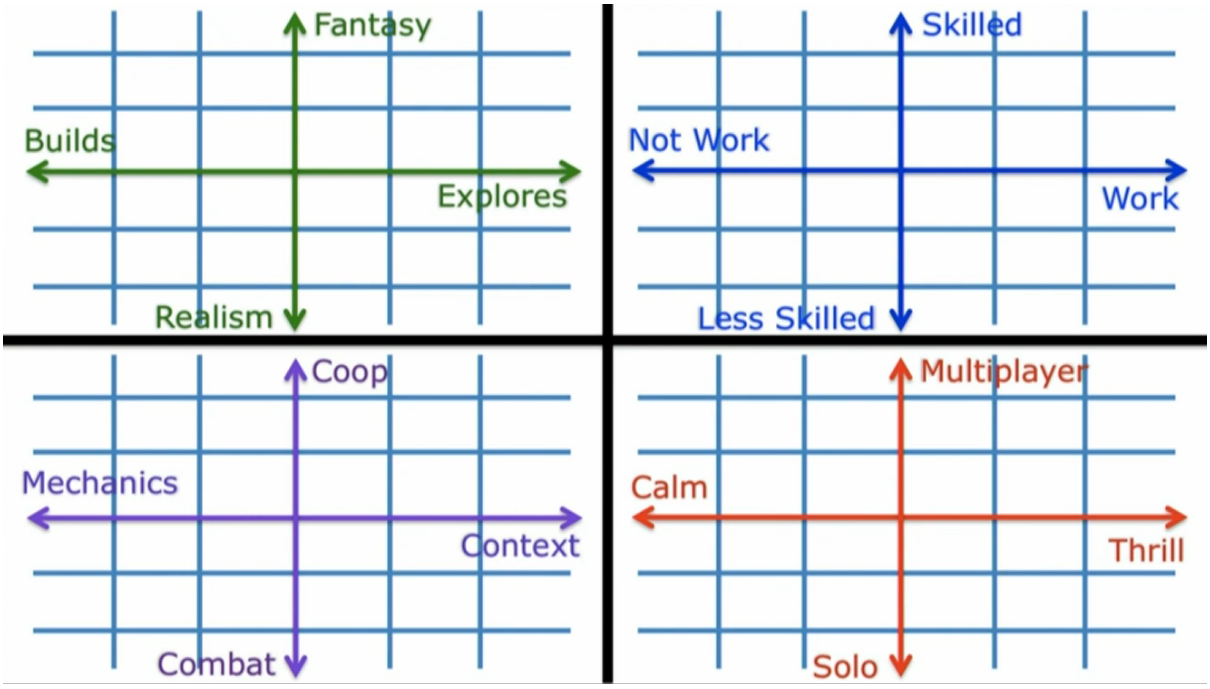


Figure 4 Taste Maps in Engines of Play (VandenBerghe, 2014)

The maps represent player investment towards a particular experience – similar to Bartle's player taxonomy. Each graph, seen in **Figure 4**, represents a personality dimension of players, rather than a player type. There is also the distinction of axis numbers. Taste Maps uses an individual axis to describe the personality trait. On the other hand, Bartle uses multiple axes.

The remaining two facets of the "Engines of Play" focus on the player's engagement with the game, wherein interests eventually evolve towards a quest for enhanced overall satisfaction (VandenBerghe, 2014). This transition from the initial Taste Maps to other priorities is where the application of SDT becomes significant. This is where SDT is used to propose a way to measure this shift, equating the transition over time of a player's game experience to the "Consumer's Journey". Such an approach empowers designers to craft experiences that not only captivate players initially but also maintain enduring appeal.

This framework acknowledges the necessity for designers to factor in motivations for gameplay. Moreover, deeper insights into these motivations are unveiled through psychological studies. VandenBerge's notion that players engage in games for similar reasons to their real-life pursuits reinforces this concept (2014). This thesis seeks to bridge these aspects by integrating the Hexad framework of player types, capitalizing on this association.

2.2.1.3 Mechanics, Dynamics, Aesthetics

The Mechanics Dynamics Aesthetics framework, known as MDA, distinguishes itself as one of the most universally acknowledged and extensively applied models in game design. Its central aim is to offer a thorough assessment of game components, aiding in the development of seamless gameplay encounters. Emerged from the "Game Design and Tuning Workshop" held at GDC, it was conceptualized by Hunicke, LeBlanc, and Zubek in 2004. This framework accentuates three core elements of design:

- Mechanics – encompassing game components such as rules, code, algorithms, etc.
- Dynamics – representing the real-time behavior of mechanics, including responses to player inputs and system outputs
- Aesthetics – aiming to evoke desired emotional responses and affect

This framework looks at both the roles of the designer and the player, creating a spectrum with how a game should be considered from both perspectives. Each part of MDA is a "lens" to view the game from – they are each separate components but are connected as a whole.

MDA presents a dual viewpoint that takes into account both the perspectives of the designer and the player, thus establishing a comprehensive spectrum for the assessment of games. Each facet within the MDA framework functions as a distinct vantage point for analysing a game. Despite their distinctiveness, these facets interconnect harmoniously to form a unified entity.

However, the somewhat arbitrary classification of the eight types of enjoyment and the absence of foundational principles supporting the defined emotional reactions emphasize the need for a solid theoretical foundation concerning emotions. Considering that this thesis extensively explores players' emotional reactions and the impacts stemming from game mechanics, the MDA framework also stands as an initial reference point in shaping the models discussed in **Chapter 4.**

2.2.1.4 The Layered Tetrad

The Layered Tetrad has been introduced here because of its synthesis of three existing design frameworks (Bond, 2014).

The three it utilized were:

- MDA
- Elemental Tetrad

- Formal, Dramatic, and Dynamic Elements

The framework is composed of three “layers”:

- Inscribed Layer (similarities with Elemental Tetrad by Schell – components directly built/programming into game)
- Dynamic Layer (interactions of player with the game)
- Cultural Layer (impact of game on culture/society)

And within each of these layers are four “elements”: Mechanics, Aesthetics, Narrative and Technology (Bond, 2014). These elements are intertwined and offer distinct viewpoints on various phenomena, contingent on the layer or lens they are situated within.

The Layered Tetrad aims to establish itself as a framework encompassing design considerations at multiple levels. The application of this framework demonstrates its significance as a pivotal developmental tool, facilitating the integration and arrangement of game elements. The importance of discussing this framework is to exemplify that design frameworks don’t necessarily come into inception from just ideas, but also from a synthesis of previous ideas. This amalgamation can arise due to various factors, including identified shortcomings in earlier frameworks or the potential for further refinement of existing ideas. Such synthesis constituted the foundational design approach for the initial models in the framework development presented in this thesis.

2.2.2 Other Emotional Design Perspectives and Frameworks for Games

Research into design approaches and frameworks in video games with a focus on emotions or determining what emotions are emitted are sparse and hard to find. With VR emerging as a new and popular medium for video games, there is also a clear lack of research into this growing technology that seeks to be covered.

Before addressing how designing for VR is different and some design principles to consider following, this section will briefly discuss several proposals by other game designers or researchers.

Research focusing on design approaches and frameworks in video games, particularly those centred on emotions or the determination of emitted emotions, remains scarce and challenging to come by. As Virtual Reality (VR) gains momentum as a novel and increasingly popular gaming medium, an evident research gap exists in exploring this technology comprehensively.

Amidst a backdrop where VR has experienced a resurgence, it's important to acknowledge the historical context. VR faced a decline, but its revival was catalysed by initiatives like the Oculus Kickstarter campaign. However, this resurgence happened swiftly, leaving limited time, space, and resources for in-depth research to evolve alongside this rapidly evolving medium. This scarcity of substantial research underlines the need for a closer examination of design considerations and principles specific to VR, which will be addressed in the subsequent section.

Once such approach was done by Freeman, in a process he refers to as emotioneering (2004). He approaches emotions in games in a multi-faceted way, attempting to categorize the elements essential in games that use emotions, both for entertainment and commercial purposes. These classifications were intended to enhance the overall game experiences. Freeman's comprehensive compilation encompassed an extensive list of 300 techniques, grouped into 32 distinct categories (Freeman, 2004). Notably, a significant proportion of these techniques are grounded in narrative components. However, the intricate nature of this approach, predominantly centred around narrative elements, rendered it less pragmatic for adoption in this thesis.

Another game designer who delved into this concept of 'engineering' emotions is Bura, albeit with a more approachable and pragmatic perspective (Bura, 2008). His conceptualization is visually outlined in **Figure 5**.

	Freedom	Mastery	Data
Action	Opportunities, Tools and Abilities	Trained reflexes, Tactics	Game world resources and collectibles, Operational rules
System	Exploration, Experimentation, Purpose	Learning skills and using them to gain more control	Preparation, Constitutive rules
Self	Strategy, Creativity	Exploiting skills, knowledge and metagame data	Mementos, Achievements, Memories
Social	Community support, Shared experience	Competition, Cooperation, Teaching skills	Status, Metagame, Implicit rules

Figure 5 Bura's Emotioneering Approach (2008)

Bura's framework addresses four distinct levels: Action, System, Self, and Social. At the Action level, it encompasses the immediate reactions and visceral feedback loops during gameplay. The System level pertains to cognitive functions and logic. Moving to the Self level, it delves into introspection, thoughts, objectives, and experiences. Finally, there's the Social level, which concerns shared experiences, relationships, and cultural aspects (Bura, 2008). These are mapped to different gameplay categorisations – Freedom, Mastery, and Data.

Bura's approach, despite appearing visually straightforward, revealed complexities when implemented. The mapping of emotional responses used a slider scale which lacked clear definition, and the interpretation of emotions remained quite flexible. While the subjective nature of emotions precludes absolute precision, employing well-defined measurement methods can limit uncertainties and reduce error margins. Bura's approach, while more comprehensible and user-friendly for game designers than Freeman's model, still exhibited a degree of convolution and lacked the desired conciseness.

Level of emotional design	**Relation to the Structural Elements of Games**	**Domains of learning**
Visceral (Aesthetic)	The emotional reflex towards the appearances of game elements. The affective processing makes rapid judgement of what is good or bad, safe or dangerous. The automatic, prewired visceral level is biologically determined.	Affective (Attitude)
Behavioural (Functional)	The pleasure towards the effectiveness of using game elements. The behavioural level contains the brain processes that control in-game behaviour	Psychomotor (skills)
Reflective (Socio-political & economic)	The rationalization and intellectualization of game elements. The reflective thought does not have direct access either to the sensory input or to the control of behaviour.	Cognitive (knowledge)

Figure 6 Connection between the Three Levels of Emotional Design and the Three Domains of Learning in Relation to the Structural Elements of Games (Baharom, Tan, and Idris, 2014)

The third approach is presented by Baharom, Tan, and Idris, a collaborative approach that saw further areas of knowledge incorporated into a framework, those being domains of learning and emotional design (2014). See **Figure 6** for the visual representation of the framework.

Like Bura, it formats the approach in a table, mapping the three emotional design levels presented by Norman to structural elements of games, which is then likened to a domain of learning (Baharom, Tan, and Idris, 2014). This approach is a good reference in incorporating other research areas, but the game elements mentioned were the actual emotional reactions felt by players. While this can be useful later in determining emotional responses of the frameworks created, it does not explicitly say what game mechanics or game elements can be changed or how changing them elicits different emotional responses. Hence, this approach was not suitable for establishing correlations between mechanics and emotions, as intended by this thesis.

However, this thesis uses the approach of this framework as a point of reference when creating the framework because of its combinatory approach using existing ideas – those being Norman's emotional design and domains of learning from education.

2.3 Design with Emotions

Numerous frameworks and methodologies have been developed for the game design process; however, a noticeable void remains in establishing a direct link between emotions and mechanics. The absence of an established emotional design framework spurred me to recognize this gap and offer a solution. However, emotions are considered in design frameworks beyond the realm of games. This presents an opportunity for a hybrid approach in this thesis, where an emotionally inclusive framework can be fused with a game design framework. Such research areas include Emotional Design and Affective Design. The two are tightly intertwined in their definitions and methodologies, and thus will be discussed together in the same section.

2.3.1. Emotional Design

The preceding section addressed game design frameworks, but it's essential to underline that these frameworks generally lacked comprehensive emotional considerations in their designs. While MDA did make a reference to its defined emotions, there was an absence of a solid theoretical foundation underpinning these emotions that seemed measurable or quantifiable. Nevertheless, other domains within design incorporate emotions into their processes, particularly in product design and Human-Computer Interactions.

Emotional design deals with how we can create designs that evoke emotions. Traditionally, the primary purpose of this area is to understand how to evoke positive user experiences.

This is because the initial use of emotional design was towards product design, which aimed to elicit a positive experience from the user. This was to ensure the user kept using a product or bought more of a product. Whilst this is useful to know, ultimately it will be applied differently to games design because of the aim to address all different types of emotions, including those that may be referred to as “negative” emotions (*e.g.* fear, tension, boredom). The primary figure in Emotional Design is Norman. Norman proposed a framework to reach users on three different cognitive levels – visceral, behavioral, and reflective – to enable users to develop primarily positive associations with products, brands, and more (Norman, 2005). The visceral level, or the most basic human mechanisms, is related to our unconscious thoughts. As the base level, this design component is concerned with the appearances of a product (Norman, 2005). The behavioral level is a step up and has a bit more thought and cognitive processing involved – although still mostly subconscious. Rather than the instantaneous response, this level focuses on the effectiveness of use and the pleasure of using the product. It is wholly focused on function, performance, and usability (Norman, 2005). The last level, or the reflective design, is as the name suggests – the feelings after we have used the product. When reflecting, we are interpreting and understanding things, rationalizing our experiences (Norman, 2005).

Emotional Design can be understood under HCI, or Human-Computer Interactions, just as Affective Design does. For example, Norman’s framework of emotional design showcases an effective design through its “a modality of interaction perceived as simple and intuitive”, and by the users’ involvement at the affective level (visceral) “through the use of physical features such as sight, touch, and sound” (Pallavicini, Pepe, Ferrari, Garcea, Zanacchi, and Mantovani, 2020).

2.3.2 Affective Design

The aims of affective design are to understand the emotional relationship between a user and a product, and how the product conveys “affectively” through the product’s features. When we integrate the domain of *affective design* into technology, bringing in both the creation of and interaction with systems that sense, identify, respond to, and influence emotions, we delve into the realm of *affective computing* (Daily et al., 2017). In terms of games, this would be the relationship between the player and game, and how the game conveys its emotions – through mechanics and gameplay, aesthetics of the game level and style, sound, and all other components.

Affective computing pertains to the realm where technology possesses the capability to identify, replicate, and comprehend human emotions (Picard, 2000). This interdisciplinary domain was initially introduced by Rosalind Picard in 1997, with a proposal towards the automatic measurement and identification of human emotions (Picard, 1997). This field encompasses various disciplines, such as psychophysiology, computer science, biomedical engineering, and artificial intelligence (Marín-Morales et al, 2020).

The focus of this research area is centred in Human-Computer Interactions, or HCI, with the goal of designing and creating natural human-user interfaces. This means creating software that is responsive to the user's emotional needs, and providing an experience that connects humans to technology. For the gaming industry, the most recent research has been focused on analysing players' behaviours and identifying players' affective states during play (Shaker, Asteriadis, Yannakakis, and Karpouzis, 2011). Thus, "closing the affective loop within games context" would involve both the recognition and modelling of players' affective states, in addition to identifying the game elements that elicit particular player behaviours (Shaker et al, 2011). This knowledge would then be used to generate player-adaptive gameplay by using the players' emotions to modify gameplay depending on the affective state (Shaker et al, 2011).

In terms of gaming, affect can be used (De Byl, 2015): in the development of believable AI, NPCs, and characters; to evoke a relatable and compelling narrative; to facilitate enjoyment or flow – the maximum immersive state a player can be in; to enable haptic interfaces; or even to motivate learning. To attract a wider audience of players, games are beginning to utilize adaptive game mechanics because of their ability to cater gameplay at the individual level, rather than a specific group of users (Gilleade and Dix, 2004). There is a particular subfield in affective computing and design for affective games – to study how to design games that can react to player emotions and eliciting targeted emotions to the player. To accomplish this would involve research on "how to measure and detect human emotions", and "how to adapt videogames to the perceived emotions" (Lara-Cabrera and Camacho, 2019). Whilst this thesis will not be using a computer to measure or detect emotions – preferring a qualitative method – the aim is still the same. In terms of adapting the videogame, however, the thesis has a different goal – designing the game mechanics from the start with a specific emotion in mind.

2.4 VR Design

The problem with applying design approaches made for video games on traditional mediums such as PC or console, or even applying design approaches for products, arises when considering how a user *experiences* VR. VR is an immersive and realistic technology that puts the player wholly in the virtual environment. The movements and interactions line up with reality through the controls and movement of the headset and controllers. If the player moves in real life, the game space will react as if it were reality. When the player reaches their hands out, so do their hands in game – whatever the appearance of their hands may be. This does not mean their character, or actions they perform, or even the world appearance are realistic, however. Fantastical elements still exist in VR games, but the level of immersion in the actions a player can perform create a different experience from traditional mediums.

This level of immersion and realism cannot be replicated to other mediums. Additionally, what works well in traditional mediums cannot necessarily be transferred to VR. For example, the HUD, or heads-up display, typically is a status bar in games that relays information to the player, such as their health. HUD does not exist in VR games and would be out of place. Also, with a higher physicality level, or body involvement of VR games, there is a stronger emotional response elicited (Pallavicini and Pepe, 2020). This creates a different design goal that is not normally considered for traditional games. To understand the differences between this medium, and others, a brief introduction to how VR works and some understandings of the technology will be discussed.

2.4.1 Differences of Designing for VR

To grasp the nuances of design distinctions between Virtual Reality (VR) and other gaming mediums along with 3D environments, the term "Virtual Reality," or VR for short, encapsulates an immersive experience within a headset that surrounds the player's visual field in a 360-degree panorama. Within VR, players have the freedom to turn and move just as they would in the physical world, while the virtual game environment responds in tandem with their actions. As emphasized by Johnson-Glenberg (2018), it's crucial to differentiate that the depiction of a three-dimensional object or avatar moving across a standard computer monitor does not constitute VR. An example hardware of VR can be found in **Figure 7**.

Figure 7: VR Hardware for the Quest 2 (Meta)

In terms of technology, VR gaming systems achieve this immersion with several input devices tracking the user's body: "the head mounted display tracks head rotation; motion controllers such as the Oculus Touch track hand movements and sensors capture hand and head position within the tracked space" (Martel and Muldner, 2017). There is also terminology regarding the navigation metaphors that greatly differ from traditional games. The issue with the novelty of VR is there is no established control scheme that is dominant or widely preferred (Martel, Su, Gerroir, Hassan, Girouard, and Muldner, 2015). Therefore, many options have been introduced into VR games. While there were initially many different designs of controllers and methods of movement, there is slowly an approach towards more uniformity as it becomes better understood what performs the best with users.

The first of locomotion discussed can be classified as physical, and is focused on "roomscale-based metaphors", such as physically walking around in the real world environment, to navigate the virtual environment (Marín-Morales et al, 2020). While this allows the player to walk around freely inside a physical space, there is limitations to how big the physical space is. Therefore, unless the environment of the game is limited enough to match a player's space (i.e. the size of their room they are playing in), other locomotion methods need to be introduced.

An alternative to solve this problem includes the "Walking-in-place" method, which involves the player performing a virtual movement to navigate around. This could include examples such as the player moving their hands to mimic a walking motion, or by performing "footstep-like movements while remaining stationary"(Marín-Morales et al, 2020). These types of movement ensure the player remains in the tracked area for VR play.

Lastly, and arguably the most popular locomotion – in part due to its ability to counter cybersickness – is through joysticks or similar methods (keyboards, trackballs, etc). The method through joysticks is primarily a point-and-click teleportation-based metaphor, done through either linear or parabolic aiming methods, exemplified in **Figure 8** (Matviienko, Müller, Schmitz, Fendrich. and Mühlhäuser, 2022). It works by allowing the user to point where they want to go, projecting an arc the player can visually see where they would be teleported to before clicking via the joystick. This results in an "instantaneous jump" (Marín-Morales et al, 2020).

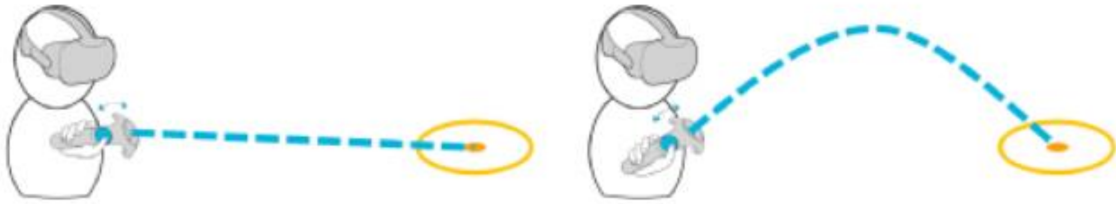


Figure 8: VR Locomotion (Matviienko et al., 2022)

Each locomotion method requires further research to understand the effects on the players. However, every method has its own benefits that are slowly being understood: "walking-in-place [metaphors] have become more robust and user-friendly", roomscale-based metaphors now have increased coverage areas provided by low-cost tracking methods, and "joystick-based locomotion now addresses virtual sickness with effective dynamic field-of-view adjustments" (Boletsis, 2017).

Because of the different types of interactions in VR, this medium offers a physicality to it that cannot be replicated in other mediums. VR is considered a more immersive technology largely because of this physicality and total immersion in a 360◦ virtual environment, which can create a greater sense of presence. "Thus, presence is deemed the first profound affordance of VR" (Johnson-Glenberg, 2018).

Presence and immersion are ludological terms that are often paired together – with higher presence, the player is more immersed in the game experience. Presence refers to the scenario when a player is fully "there" and "present" in the game, where the player's perception views the game as the real world. One of the most adopted definitions, "perceptual illusion of nonmediation", comes from Lombard and Ditton (1997). Therefore, there are no interruptions to the perceptual illusion of being in the virtual world – something VR achieves more due to the physicality. When compared to a medium such as PC games, where the player must use a mouse and keyboard to interact and are limited to a monitor to view the games from, the presence provided by VR through two controllers mimicking hands and a headset that provides views of the virtual world from every angle, this physicality becomes more easily understood.

While various factors can influence the sense of presence, the existence of game design frameworks aims to enhance gameplay experiences and consequently amplify the feeling of presence. Among the widely adopted categorizations of presence, spatial presence stands out as one of the primary principles (Pallavicini, Pepe, Ferrari, Garcea, Zanacchi, and Mantovani, 2020). This classification underscores the significance of spatial immersion (Schubert, Friedmann, and Regenbrecht, 2001), implying that VR inherently enjoys an advantageous position compared to other mediums.

However, with this heightened presence and immersion through its physicality and different forms of interactions comes other design considerations. The physicality of VR, by default, brings a higher degree of physical activity during play. Designers must consider the physical comfort of a player, their physical ability to perform the game's actions, the need for breaks in between more intense physical activity, and each individual's different capabilities (fitness, height, disability, …) (Desurvire and Kreminski, 2018).

Other considerations include the virtual environment itself. For example, shelf heights in a VR environment could be out of reach depending on how the game and headset adapt to players of different heights and can consequently ruin the gameplay experience of a player if such options are denied to them but afforded to others (Soler, Contero, and Alcañiz, 2017).

On the other hand, the flipside is the benefits of VR interactions in creating more presence through its capabilities. Through examples such as haptic feedback, the feeling of pulling back a bow can be mimicked. In one of the most basic games by Valve called *The Lab* (Valve, 2016), you play as an archer defending a castle from enemies. Pulling back the bow gives you haptic feedback, mimicking the tension felt when using a real bow. This information is sensed, rather than processed, and can trick the player into the sense of reality that allows the player to view VR as their real life environment (Soler et al, 2017). Therefore, when we design games for VR, we cannot take a traditional design approach used for games. Whilst some emotional frameworks have been explored in this Chapter for games design, there is not an existing framework found for VR. Because of these separate design considerations, this thesis's framework is focused on the design of VR games in particular.

Before approaching emotional design for VR and how we can make specific interactions that elicit our desired emotional affect, the effectiveness of the VR game itself needs to be ensured. There are existing heuristics that have been made specifically for VR usability, to ensure there are no usability issues that can interfere with a player's immersion. These heuristics, alongside feedback gathered from current VR developers on both popular and smaller VR games – such as *Half Life: Alyx* (Valve, 2020), have been collected to create a concise list of heuristics the VR prototypes of this thesis will follow. In order to understand these heuristics, a brief introduction to how VR functions will be discussed to ensure an understanding of how the medium is interacted with.

2.4.2 Heuristics

With the difference in medium and mode of interaction with VR, there are new usability and playability challenges for developers, designers, and UX researchers (Desurvire and Kreminski, 2018). Some newer issues of such an interactive medium include physicality, spatiality, and "new or intensified physiological, psychological, and social considerations" (Desurvire and Kreminski, 2018). For example, VR presents the problem of "cybersickness", often referred to as motion sickness by players in VR (Agić, Murseli, Mandić, and Skorin-Kapov, 2020). Scientifically, it can be defined as "a mismatch between vestibular and oculomotor sensors, where a person has a feeling of movement even though there is none", which results in the player experiencing nausea, headaches, dizziness, and sweating (Agić et al, 2020). Usability principles would address such an issue, by introducing guidelines that address this cybersickness, such as avoiding a narrow field of view, or offering customization for the type of movement the player uses (Agić et al, 2020).

Usability and playability have been well-documented in video games and similar subject areas, however there are few that have been designed specifically for VR (Pinelle, Wong, and Stach, 2008; Federoff, 2002; Desurvire and Wiberg, 2009; Desurvire et al., 2004; Sánchez et al., 2012; Virvou and Katsionis, 2008). The best-known existing list of heuristics for VR is currently the Virtual Reality PLAY or VRPLAY guidelines (Desurvire and Kreminski, 2018), which builds upon its predecessor, Heuristics to Evaluate Playability, or HEP (Desurvire and Wiberg, 2009). HEP was not designed for VR, and thus VRPLAY was created to address the difference in usability requirements. HEP has four categories: Game Play, Game Usability, Game Mechanics, and Game Story, and was proven effective in a study from CHI 2004 (Desurvire, Caplan, and Toth, 2004).

Alternatively, VRPLAY is split into five categories: Usability, Playability, VR Immersion, Creative VR, and New Player Experience. These are drawn upon existing research in both usability and playability in games, software, and in VR research – including considerations for "physical, psychological, social, and ethical perspectives on VR" (Desurvire and Kreminski, 2018).

For this thesis, the VRPLAY heuristics were followed as usability guidelines to ensure effective VR play without hindrances to the performance of the thesis' framework.

2.5 Emotions

Emotion present itself as an expansive term with no precise or agreed upon definition (Baillie, Toleman, and Lukose, 2003). In general, the common person might be able to describe the concept of emotion, but attaching a definition is surprisingly difficult – "almost everyone except the psychologist knows what an emotion is" (Young, 1973). To address and justify the emotional framework this thesis will use, a background regarding the major definitions and approaches of emotions shall be discussed.

2.5.1 Defining Emotions

To deconstruct the vague concept of emotions into a finite definition, we should begin by clarifying other concepts that often get tied to emotions, before examining current perspectives within psychology.

Emotions are often associated with related terms like "feelings, moods, and sentiments" (Saraiva and Ayanoğlu, 2019, p.2). However, it's important to note that these concepts hold distinct meanings. Feelings pertain to personal experiences of emotions and arise after the emotion itself. They encompass a subjective "state of mind resulting from an individual's assessment of an event's pleasantness or unpleasantness, such as pain" (Saraiva and Ayanoğlu, 2019, p.2). Conversely, moods, although more enduring than emotions, lack a specific trigger and may persist without an apparent cause. Nonetheless, both emotions and moods significantly influence individual behaviour, prompting shifts from one behaviour to another, aligned with the circumstances. Sentiments, often shaped by cultural influences, typically refer to the emotional inclinations one holds towards a specific product. Unlike emotions, which are often brief and fleeting, and moods, which can extend for hours or even days, sentiments have a tendency to endure (Saraiva and Ayanoğlu, 2019).

Additionally, research has shown that there are different types of emotions: Mind-Body emotions, Fast primary emotions, Emotional Experiences, and Emotional Behaviour. These categorizations are situated between the terminology previously mentioned, and the theoretical frameworks that will be discussed next. These terms will be defined in the most appropriate framework, except for Emotional Experience. This is referred to as the *core affect* (Russell, 2003). It addresses emotional experiences as a continued mental state and cover the individual's general mood, such as tense or calm.

2.5.2 Theoretical Approach of this Thesis

Traditionally, the study of emotions has been categorized into various theoretical perspectives or frameworks (Desmet, 2002). Alternative viewpoints proposed by researchers involve notions such as emotions comprising of "subjective feeling, expressive behaviour, and physiological arousal", and in some instances, including "motivational state or action tendency and/or cognitive processing" (Ravaja, Salminen, Holopainen, Saari, Laarni, and Järvinen, 2004, p.340). Numerous theoretical approaches for classifying emotions have been explored below, presenting readers with diverse viewpoints ranging from fundamental discrete theories to dimensional theories. This thesis will primarily examine emotions through the lens of dimensional theories.

2.5.2.1 Discrete Theories

Darwin (1872) states that emotions are not solely experienced by humans – they can be exhibited by other animals. Emotions are discussed in relation to natural selection, and how they function to "ensure adaptation, communication, and survival of species in different environments" (Saraiva and Ayanoğlu, 2019). Darwin helped pave the way for the first Evolutionary Theory of Emotions, which was later added onto by people such as Plutchik, with the Psycho-evolutionary Theory of Emotion (Plutchik, 1962). This theory identifies emotions as "adaptive responses to dangerous events/situations" – basically, when some occurrence becomes detrimental and threatens survival, emotions seek to restore equilibrium (Saraiva and Ayanoğlu, 2019). An example scenario where this can be observed, as provided from Desmet (2002), is when a fire alarm goes off – everyone immediately reacts by heading for the exit. In this scenario, our fear triggers the instinct to flee in order to survive the dangerous situation. "Researchers in this tradition regard the adaptive behavior (including facial expressions and states of readiness to response) as central to what emotions are" (Desmet, 2002, p.7).

Plutchik (1962) identifies six basic emotions – anger, disgust, fear, joy, sadness, and surprise. He later added onto his basic emotions with additions such as amusement, contempt, pride, and satisfaction (Ekman, 1999). In addition to this, Cowel et al. (2017) determined there are twenty-seven different categories of emotions, experienced along a spectrum.

Emotions are referred to as basic, stemming from their role in evolution as stated above, but also from their biological and social functions, and their pivotal in our development (Izard, 1992). “The assumption that emotions are evolved phenomena implies that their accompanying manifestations should be universal” (Desmet, 2002, p.8). Ekman further categorized emotions into distinct basic types: joy, sadness, disgust, fear, anger, surprise, interest, and contempt (Ekman, 1982). Ekman employed facial expressions to classify these emotions, assigning a specific emotion to each expression. He would also later update his categorization to positive or negative types.

Another perspective of understanding emotions includes “The Mind-Body”, in which emotions are considered to drive human behaviour (Weiner, cited by De Byl, 2015). These include common behavioural urges such as “hunger for food or desire for sleep” (De Byl, 2015, p.4). These basic emotions have evolved in the evolutionary process to address our basic survival needs and therefore serve as physiological motivators – thus, directly placing these emotions in the evolutionary framework.

An additive to the basic theories also includes the perspective of “Bodily-Feedback”, which primarily focuses on the “emotional experience” rather than the function of emotions. One of the initial founders of this framework was William James, a philosopher/psychologist, who put the body at the forefront of our emotional experiences (James, 1884). From his view, emotions and emotive responses are a direct consequence of “bodily expressions”, and the change that occurs is the emotion (Price and Harmon-Jones, 2015). “From this perspective, emotions are not only the outcome of, but are also differentiated by, bodily changes” (Desmet, 2002, p8).
Modern interpretations believe the term James used, “bodily change” to refer to either expressions, or changes/reactions in the nervous system (Desmet, 2002). For example, “we smile from ear-to-ear when we are reunited with an old friend” or our heartbeat races and we shiver, and then perceive such as fear (Price and Harmon-Jones, 2015).

Fast-primary emotions would also fit into this framework. This type of emotions refers to the initial response to a stimuli, our “quick-acting” emotions, including emotions such as fear and startledness (De Byl, 2015). It is more of the shorter-term counterpart to Emotional Experiences and fits in with the immediate feedback of the Bodily-Feedback framework.

Moving on through the theories of emotions, the cognitive theoretical framework brings more advanced concepts into its defining concepts. In the cognitive theoretical framework, there is a mix of both the evolutionary and the bodily-feedback. “The essence of this perspective is that in order to understand emotions, one must understand how people make judgements about events in their environment, for emotions are generated by judgements about the world” (Desmet, 2002, p.10). One of the initial founders of this framework was a psychologist named Magda Arnold, who argued that emotions entail an assessment of how an object could either harm or benefit a person (Arnold, 1960). The appraisal process describes the process of emotions within the cognitive perspective – essentially, at the base of every emotion is the direct judgement from appraising something. For example, if someone makes fun of you, you might attach anger to this remark if it is insulting, but amusement if it is a joke. A pivotal element of this viewpoint is its emphasis on attributing the responsibility for an emotion not to the event itself, but rather to the significance that an individual associates with that event.

2.5.2.2 Dimensional Theories

While a dimensional theory of emotions has previously been briefly touched upon (ex – Plutchik, who proposed his own three-dimensional model), this section will focus on the emotions being in a two-dimensional space, as “coordinates of valence and arousal (or bodily activation)” (Ravaja et al., 2004). Valence and arousal were previously mentioned in cognitive appraisals, however, the dimensional theories are best used to visually represent, as well as better understand these terms.

Valence refers to whether an experience is negative/unpleasant or positive/pleasant, whereas the arousal dimension refers to the *level* of activation correlating to the experience of emotion, such as the more extreme – excited, energized – to the lower end of the spectrum – calm, sleepy (Ravaja et al., 2004).

In terms of visualization, the two-dimensional model that theorists have suggested includes positive and negative activation (PA and NA respectively), “that represent a 45° rotation of the original main axes” (Ravaja et al., 2004). The axis for PA goes from highly arousing *positive*, such as joy, to low arousal *negative* emotions, such as depression. Diversely, the axis for NA goes from the highly arousing *negative* emotions such as fear and anger, and extends towards lower arousing *positive* emotions, such as pleasant and relaxed.

Emotional Behaviour is a more expansive approach to defining emotions but could fit into this framework due to its integration of valence and arousal. However, Emotional Behaviour also incorporates “background emotions, personal beliefs, personal goals, and rational assessment of forthcoming behavioural consequences", and focuses on emotions activating a level of motivation, thus it is an outlier but helpful to consider for future design endeavours (De Byl, 2015).

Russell created a dimensional model for the conceptualization of emotions, known as the "Circumplex Model of Affect", comprised of two basic dimensions: pleasure and arousal (Russell, 1980). As mentioned previously, the model can be visually understood along a scale in two-dimensions: Valence (positive to negative emotions – eg happy or sad) and Arousal (intensity of the Valence – eg very calm to very exciting) (Khan and Rasool, 2022). This specific model was selected as the theoretical foundation due to its perceived suitability in pinpointing precise emotional responses associated with each mechanic and potentially identifying correlations between different emotional states during gameplay. Further exploration of the utilization of this model will be detailed in the next chapter.

2.5.3 Eliciting, Identifying, & Measuring Emotions

Emotional elicitation has always proved problematic for researchers due to the fluidity of emotions to change at any given moment, depending on both internal states and external environmental influences (Doumbouya, Benlamine, Dufresne, and Frasson, 2018). "Emotion elicitation is the ability to reliably and ethically elicit affective states" (Marín-Morales, Llinares, Guixeres, and Alcañiz, 2020, p.7). Discussed in the next section, emotional elicitation is vital in the development of systems that focus on emotions' detection, interpretation, and adaptation – i.e. affective design and computing (Marín-Morales et al, 2020).

Identifying emotions elicited has given way to a multitude of methods, which can be categorized as subjective and objective measures. "Subjective measures consist of self-evaluation of the person's emotions", through measures such as multiple-choice, Likert-scale options in surveys, and open-ended responses (Doumbouya et al, 2018, p.3), whereas objective measures is more quantitative, focusing on capturing signals from the person's body and face through scientific tools based on ocular devices (webcam, eye tracker, Kinect …), physiological sensors (EEG, Galvanic Skin Response, EMG), or even Facial expression analysis and recognition (Littlewort, Whitehill, Wu, Fasel, Frank, Movellan, and Bartlett, 2011).

Direct feedback is obtained via biometric sensors, such as the EEG and galvanic sensors.

“The main idea behind this is the fact that there are many physiological effects related to emotions as sweating, heart-rate, and corporal heat, to name a few” (Lara-Cabrera and Camacho, 2019, p.2). Essentially, the feedback from such sensors can be used loosely to understand the arousal of the person, or more accurately with the advanced technology such as EEG (Lara-Cabrera and Camacho, 2019). The main advantage of direct feedback is that the feedback gathered provides quantitative measures that can be assembled to compute emotional states of the person.

The downside of such methods arises when looking at the limitations to the play experience of the user. In terms of playing games, such devices can get in the way of playing, and thus cause the user to feel uncomfortable or frustrated, directly impacting the results (Lara-Cabrera and Camacho, 2019). This is particularly true in VR, with the hardware already being on the head and wrists – any further biometric tools would prove invasive to the play experience. As an alternative method, there is indirect feedback.

Indirect feedback attempts to solve these issues by inferring emotions from indirect features. These could be how the user is playing the game – pressing the buttons of a gamepad (mouse/keyboard/controller), or how the user is moving their in-game character. “However, the emotional feedback must be correctly defined in order to obtain reliable results, something that is not always possible” (Lara-Cabrera and Camacho, 2019). Due to the results being less direct and more interpretative, this method can prove less straightforward than the former.

2.6 Summary

The journey through this thesis requires an informed exploration of diverse research domains that extend beyond the boundaries of game design. This exploration encompasses several pivotal spheres:

- Game Design (Frameworks and emotional design as applied to games)
- Designing with emotions beyond the gaming context (*e.g.* Affective Design, Emotional Design)
- Designing for Virtual Reality (VR) (emphasizing physicality, presence, and heuristics)
- Definition of emotions and associated theoretical frameworks

The synthesis of this research relies on a multidisciplinary approach, drawing insights from various fields that converge on the central themes of this study: emotions and design. Our examination of the design domain embraces games design frameworks and the application of emotional design to games, while also encompassing methodologies for incorporating emotions into non-gaming contexts (such as Emotional Design and Affective Design). The study also investigates VR design, incorporating perspectives from both academia and industry experts to illuminate the distinctive considerations engendered by this immersive medium. Complementing these practical aspects, the theoretical foundations of emotions are drawn from the realm of psychology, and the circumplex model of affect from Russell (1980) aids in comprehending the spectrum of emotions.

As the thesis unfolds, the initial framework design probes game design frameworks such as MDA, illustrating their application within the context of games (Hunicke, LeBlanc, and Zubek, 2004). Subsequent segments explore design methodologies, including the concept of emotioneering, and frameworks that incorporate multiple areas of research, such as the combination of domains of learning with Norman (Freeman, 2004; Baharom, Tan, and Idris, 2014). The distinct attributes of VR design are scrutinized, considering insights from academia and industry professionals. Ultimately, the synthesis of this multifaceted exploration leads to an enriched comprehension of emotional design and its intersections with game and VR design, offering a holistic perspective on the intricate interplay of emotions and design elements.

Chapter 3: Methodology

3.1 Introduction

This chapter outlines the methodology used to design a framework for VR mechanics that elicit targeted emotions. The framework's understandings were verified through a pilot study. The framework's design was then used to design and develop two VR prototypes, which was play-tested in the main study. Qualitative methods, including surveys, interviews, and observations were used to collect data. This chapter begins by addressing the underlying research assumptions and philosophy of this thesis, before defining the theoretical framework and methodology used. The data collection methods will then be introduced, followed by the Research Design and ethics.

3.2 Underlying Research Assumptions & Methodology

One of the core underlying research assumptions of this thesis is that the same emotions can be evoked in different users in VR games, despite differences in personal experiences, cultural backgrounds, and prior exposure to VR technology. This assumption is rooted in the idea that certain fundamental emotions are shared to some extent among individuals, underpinning a universal emotional response despite variations in intensity. This notion is reinforced by the unifying nature of gaming experiences, where shared narratives and expectations can create a common emotional ground, transcending individual differences.

3.2.1 Epistemological Standpoint

This thesis takes a constructivist approach for the epistemological standpoint. The constructivist epistemological standpoint emphasizes the active role of the researcher in constructing knowledge through their interactions with the world. In the context of this thesis, the goal is to design a framework for VR mechanics that can elicit targeted emotions. This requires a deep understanding of how emotions are experienced and regulated in VR environments, which can only be achieved through active engagement with the subject matter.

By adopting a constructivist approach, I can actively participate in the design process, working closely with participants to create and test design artifacts. This allows for an iterative and collaborative approach to the research, where knowledge is co-constructed by both the participants and myself.

Overall, a constructivist epistemological standpoint is well-suited to this study as it emphasizes the active role of the researcher in constructing knowledge through their interactions with the world, which is essential for designing a framework for VR mechanics that can elicit targeted emotions.

3.2.2 Research Lens

The research is situated from the view of affective design. The affective design lens acknowledges the importance of emotional experiences in user engagement and satisfaction (Norman, 2004). However, in the case of this study, it is not just user engagement and satisfaction through positive emotions, but rather a wholly immersive game experience exploring both positive and negative emotions.

3.2.3 Methodology

The Research by Design methodology is an appropriate approach to this study as it is a design-based research methodology that seeks to develop and evaluate design artifacts. This methodology aligns well with the aims of this thesis, allowing for the creation and evaluation of prototypes that incorporate the proposed design framework.

Design-based research, or DBR, is a form of inquiry involving iteration in an environment that is designed. The processes involved in DBR include iterative analysis, design, development, and implementation (Wang and Hannafin, 2005). This methodology allows for iterative design processes and continuous improvements to the design framework. This framework was subjected to testing and refinement based on fresh insights garnered throughout the process, whether from the results of studies or increased familiarity with various VR game mechanics. Research by Design methodology also facilitated a close coupling between the research and design processes, ensuring that the design framework is grounded in both empirical research and theoretical frameworks.

This methodology begins with a problem and then pursues knowledge on the problem, and interventions that can address the problem. Once the solution is designed, it is then executed following its purpose, before addressing whether the solution performed as planned. When the solution is executed, data is collected and analysed in an ongoing iterative process to understand how it performs and under which conditions it achieves success. Various forms of data collection can be and research methods can be employed, such as field observation, in-depth interviews, and surveys (Richey and Klein, 2005).

In summation, the iterative design process of the framework alongside its application to prototypes fits within a Research by Design methodology, allowing me to provide theoretical contributions towards emotional design in games with practical solutions designers can use.

3.2.3.1 Difficulties of Research by Design

The difficulties of Research by Design come with the duality of the methodology. The main issue involves navigating the complexities of real-world situations, balancing the emphasis between all the different processes involved, while ensuring adequate control to facilitate design (Collins, Joseph, and Bielaczyc, 2016).

For this thesis, extra time was allotted with flexibility depending on how the prototype development progressed. The use of existing tools and assets in the Unity Asset store were also used to help aid the programming and assembly of the game prototypes, as these skills were not the focus of the thesis. Additionally, the scale of the prototypes was constantly reevaluated and revised to fit the timeline of the thesis while still properly testing the framework.

In the context of this thesis, a dedicated and flexible timeline has been allocated to accommodate the developmental process of the prototypes. Recognizing that the primary focus lies in designing mechanics and evaluating emotional responses rather than intricate programming or asset creation, existing tools and assets available in the Unity Asset Store were strategically employed to expedite the assembly of the game prototypes.

A pivotal consideration throughout this developmental phase was the scale of the prototypes. Regular re-evaluation ensured that the prototypes aligned with the thesis timeline while effectively testing the proposed framework. Striking the right balance between comprehensively exploring the framework's impact on emotions and adhering to practical time constraints was of paramount importance. The initial design of both prototypes embarked on a rather ambitious and expansive trajectory, perhaps overly bold for the confines of this thesis. However, the adoption of an iterative approach to prototype development played a pivotal role in curating the scope. This iterative strategy ensured that the outcomes of the evaluation retained their intrinsic value and relevance within the broader context of the research objectives.

3.3 Proposed Theoretical Framework

The theoretical basis for this thesis is the circumplex model of affect, which is a widely accepted model in psychology for understanding the relationship between emotions (Russell, 1980). The Circumplex model proposes that emotions can be mapped onto a two-dimensional circular space, with valence (positive-negative) on one axis and arousal (high-low) on the other axis. A visual depiction of the model can be found in **Figure 9**.

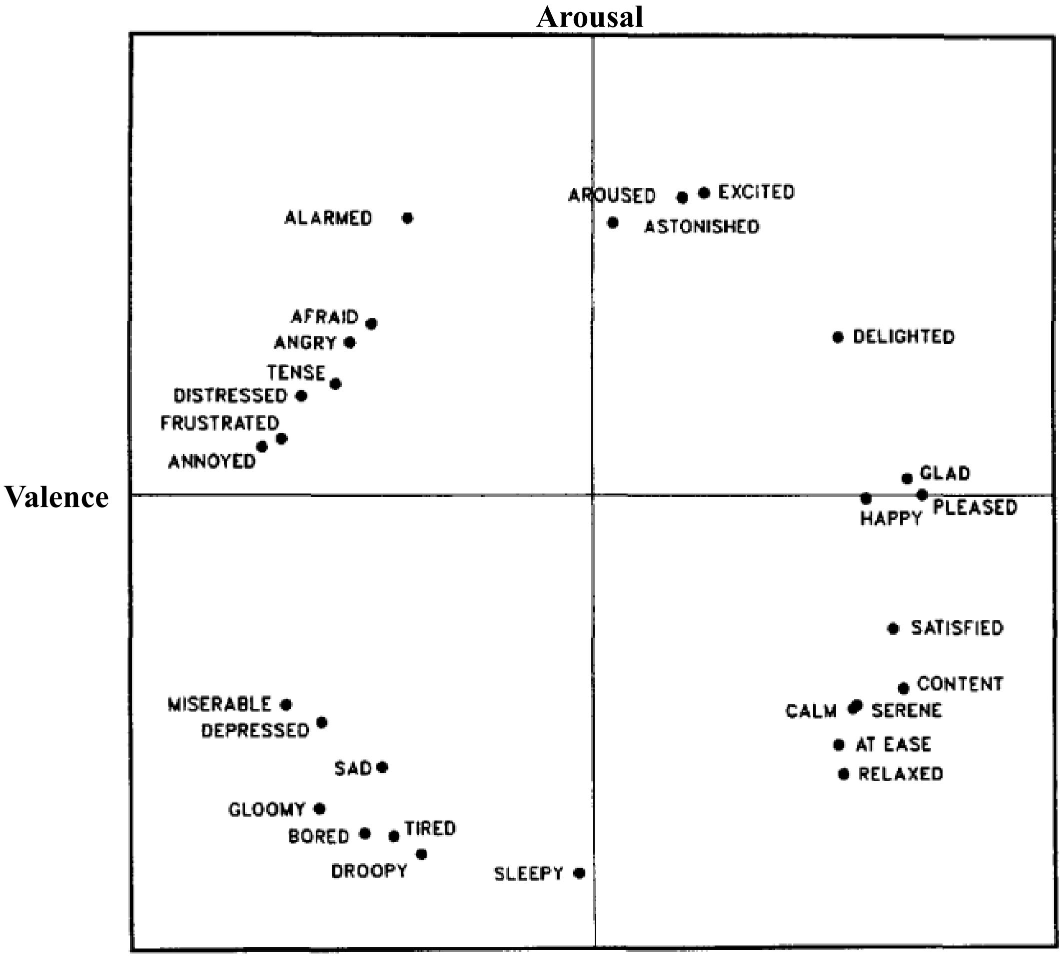


Figure 9: Circumplex Model of Affect (Russell, Lewicka,and Niit, 1989)

According to the model, emotions can be located in specific regions of the circumplex space, based on their valence and arousal levels. For example, emotions such as happiness and excitement are located in the high positive valence and high arousal regions of the circumplex space, while emotions such as sadness and boredom are located in the low positive valence and low arousal regions (Russell, 1980).

In the field of VR, the Circumplex model can be used to understand how different VR mechanics can elicit specific emotions in players. By mapping the emotions elicited by each VR mechanic onto the circumplex space, it is possible to identify which mechanics elicit specific emotions and which do not.

The decision to utilize the Circumplex model in this thesis is grounded in its ability to offer a holistic framework for comprehending the intricate interplay of emotions. This choice is particularly apt given the central aim of the thesis, which revolves around the deliberate evocation of distinct emotions in players through VR mechanics. Specifically, as I advance in crafting this framework, it becomes imperative to determine how I will identify emotions, where they will fit into the process, and examine how to recreate them.

The use of this model will facilitate the analysis of the results obtained from the empirical studies conducted in this thesis. By using two separate axis and mapping the emotions of players to the circumplex space, it will be possible to identify the most effective VR mechanics for eliciting specific emotions, and to compare the effectiveness of different VR mechanics in eliciting specific emotions.

Overall, the Circumplex model provides a strong theoretical basis for this thesis, allowing for a comprehensive understanding of the relationship between emotions and VR mechanics through precise mapping. By effectively delineating a player's affective state through this mapping process, the framework gains the capacity to harness these measurements for more nuanced emotional assessments from players. This, in turn, paves the way for meticulously tailored experiences that have the potential to exceed the capabilities of prior approaches.

3.4 Research Methods

The emotional responses were recorded through survey responses and interviews, with supplementary observations. The measurements were gathered through qualitative methods only.

3.4.1 Surveys

Surveys were distributed to participants before and after engaging with each VR prototype. The surveys were designed to collect data on the emotions elicited by the VR experiences and determine the participant's player type. The survey questions were developed based on the theoretical framework, the proposed design framework and affective design principles.

Emotions were charted on the Circumplex model of affect, with validity ensured through interviews at the end of playtesting.

In the Pilot Study, emotions were initially gathered through interviews and thematic analysis. To ensure more validity and consistency with the results from participants, this process was switched to primarily through surveys in the main study with the interviews as supplementary for validity and ensuring I understand the emotional states in a more comprehensive view – how do the emotions compare between each participant. With the different terminology used during the interviews of the Pilot Study, whilst similar emotions could be categorized and mapped, it was hard to get precision. The survey adaptation and having participants map their own emotions would offer more precision and offer better understanding on the similarities of a player's affective state.

3.4.2 Interviews

All interviews were semi-structured and focused on specific themes, primarily centred around emotions experienced and the VR mechanics of the playtesting. Nevertheless, the approach to interviews varied between the two studies. With a semi-structured interview, I was able to follow predetermined questions to understand initial emotional responses, but also has the flexibility to ask follow-up questions based on the participant's responses. This approach allows for a deeper exploration of participants' experiences while still maintaining some level of consistency in the interview process.

For the pilot study, semi-structured interviews were carried out with participants following their interaction with the VR game. These interviews were designed to gather comprehensive insights into the emotions they experienced, while also allowing for exploration of mechanics that particularly resonated with each participant. All interviews were recorded in audio format and transcribed for subsequent analysis.

In the main study, interviews retained a semi-structured format while being complemented by comprehensive questionnaire responses. This questionnaire enabled participants to map their emotions with greater precision. The interviews in the main study aimed to delve into participants' survey responses, offering insights into their reasoning behind emotion selections and ensuring a thorough collection of information from each participant to make sure the range of emotions felt were accurately captured.

3.4.3 Observation

Observations were employed to reinforce the findings derived from interviews and questionnaires. This encompassed documenting participants' actions and movements in the VR environment, alongside their verbal and non-verbal responses. These observations served as supplementary data during gameplay analysis. Instances where movements or actions corresponded to potential emotions were documented. For instance, if a participant expressed joy or excitement during a specific mechanic, I could refer to the recorded video to observe their precise reaction. Some participants conveyed their emotions through verbal cues like exclamations, while others displayed their feelings through more physical interactions such as testing all the ways to interact with an object (turning upside down, grabbing with both hands, throwing, etc).

Patton emphasized the constraints of solely relying on verbal expressions for insights. To achieve a more comprehensive comprehension, direct observation of the phenomenon in question proves to be a notably effective approach (2014). Observation helped to better understand themes and trends, offering an additional means of recognizing potential emotions expressed by the participants.

3.4.4 Questionnaire and Interview Design

To ensure the validity of the study, several measures were taken. First, the survey questions and interview questions were guided by several reliable resources. The survey itself incorporated the theoretical framework – Circumplex Model of affect – to both map the emotional responses of the gameplay experience, and pinpoint precise emotional responses from each mechanic. Likert scales were also used to better understand the intensity of the emotions, which I used at the start when playtesting VR games, alongside the model of affect. However, the Likert scales were not used for the official studies because of its eventual overlap with the answers from the map of emotions previously done. The interviews were designed to be semi-structured with guiding questions but open-ended responses, with the goal of understanding the emotional response of the player and identifying key terms for later analysis. If answers were unclear, I would prompt further discussion to better understand a participant's description of their experience.

3.4.5 Sampling for participant selection

The sampling for participant selection was a three-fold process: starting with purposeful sampling, then moving to convenience sampling, and finally incorporating random sampling. Initially, purposeful sampling was employed. Furthermore, opting for game design students as my purposeful sampling aligns with the target users of this framework, as they represent the individuals for whom the design is intended.

To ensure an adequate pool of participants, students from the Games Design department at Brunel University London were selected for this study. This choice was motivated by three primary factors.

Firstly, the students' familiarity with game technologies was advantageous. While some participants had no prior experience with VR, their existing knowledge of game technologies streamlined the process of familiarizing themselves with the VR headset, controllers, and gameplay mechanics. Without this foundational understanding, considerable time might have been spent at the beginning of sessions orienting participants with VR technology. Given that playtesting sessions already spanned from one and a half to three hours each, this deliberate sampling strategy was implemented to accommodate enough participants within the testing periods. Moreover, the aim to sample participants aged eighteen and above was also fulfilled through this approach.

Secondly, there was a need for participants to exhibit a range of familiarity and experience with VR. Finding a participant pool that encompasses individuals who have never used VR, as well as those with extensive VR experience, is challenging. However, focusing on students from the Games Design department enabled the recruitment of participants with varied levels of VR familiarity and experience, thereby fulfilling this requirement.

Lastly, engaging game design students, who are poised to enter the games industry upon completing their studies, proved beneficial since they represent the target demographic for which this study is designed. As potential future game designers, gathering feedback from a population closely resembling the intended audience of this framework provided potentially more valuable insights than other demographics.

Following this decision, convenience sampling was used. Depending on the time of my study, and being located on campus, not every student would be able to attend. Due to this, convenience sampling was used to find students that were able and willing to participate based on the constraints of my study's time and location.

Within the student base, however, random sampling was followed. Participants were recruited from the games department with no specific requirements regarding grade level, age, gender, or any other factors. As Flick noted, random sampling is employed in quantitative research to eliminate any potential biases in the sample (2018). The additional aim of random sampling was also to ensure reliability in the results, which refers to consistency in the measurements – important for determining the stability and quality of the data obtained (Rust and Cooil, 1994). For this thesis, that would mean reliability with the framework's performance in another design scenario.

Participants were selected based on their availability, and willingness to participate in the study. Participation was voluntary, and all participants signed an informed consent form prior to engaging with the study.

The aim of the pilot study was at least 5 participants, while the aim of the main study was 25 participants. The pilot study ended up with 17 participants, while the main study reached exactly 25 participants. The main study had a broader range as it was conducted at a time when a wider range of people were available.

3.4.6 Considerations for Quantitative Methods

There was initial consideration for quantitative data methods during this thesis. The idea was to use Galvanic Skin Response, and potentially EEG, to get data to back up the qualitative results from the other methods. The reason this ended up being removed from the methods is because of the equipment's invasive nature. While viable with other game mediums, VR involves a heavier headset and controls to be held in both hands. Introducing additional equipment for participants could disrupt their playtesting experience, potentially leading to skewed data due to frustration and subsequent negative emotional responses. This aspect raises questions about the trade-off between the value gained from additional data and the potential negative impact on the overall output. By including multiple data collection methods with supportive secondary methods, I aimed to ensure enough data to reach clear results on the affective states of the participants without any disruptions.

3.5 Data Analysis Method

Thematic analysis is a widely used qualitative research method that involves identifying and analysing patterns or themes within the data. It can be used for a range of qualitative data, including interviews, focus groups, and open-ended survey responses. Thematic analysis allows for the identification of common themes, patterns, and meanings that may be present in the data. Thematic analysis is the most appropriate method to analyse my data because of this thesis' aims: identifying the underlying patterns / meaning in the data.

In this thesis, I am interested in understanding the emotional responses of students to the mechanics in the VR prototypes. Thematic analysis would allow me to identify patterns of emotional responses and to explore the factors that contribute to those responses.

Thematic analysis is more aligned with my research question due to its flexibility and iterative nature, mirroring my chosen methodology. Unlike content analysis or cluster analysis, which primarily concentrate on quantifying specific elements within the data, thematic analysis delves into the meanings and experiences expressed by participants. Given that my study aims to understand emotional experiences in the context of game interactions, thematic analysis offers a nuanced exploration of the lived experiences within the virtual environment. This approach is more fitting as it captures the complexities of emotions elicited in a simulated context rather than solely focusing on quantifiable linguistic patterns.

Additionally, thematic analysis is a flexible method that allows for inductive and deductive approaches to data analysis. In this study, the data collection methods include surveys, interviews, and observations. Thematic analysis enables a flexible and iterative approach to data analysis, which is particularly useful when working with diverse data sets.

Lastly, thematic analysis is well-suited for identifying themes and patterns in complex and nuanced data sets, such as the experiences of playtesting virtual reality prototypes. This method allows me to identify not only the explicit meanings of the data but also the implicit meanings and patterns that emerge from the data. By focusing on themes and patterns that arise from the data, I can gain a more comprehensive understanding of the participants' experiences and perspectives.

Hence, considering the data collection techniques employed in this study along with the merits of thematic analysis, it proves a suitable approach for analysing the qualitative data in this thesis. Its inherent flexibility and adaptability make it well-suited to dissecting various datasets and extrapolating insights and hypotheses. Furthermore, the application of thematic analysis aligns seamlessly with both the research inquiries and the chosen methodology. This enables me to holistically grasp the participants' viewpoints and experiences, especially relevant given that user testing, typically follows a similar pattern of observing gameplay, recording reactions, and conducting subsequent collection of feedback.

3.5.1 Data Analysis Process

When the data was analysed using thematic analysis, the process involved coding, also referred to as "the classification of events in discrete categories and labelling of these categories" (Flick, 2013). The categories chosen for coding are typically linked to larger patterns. While the individual interactions are also being observed in the data analysis, the coding in thematic analysis allowed me to understand the overarching emotional responses and the emotional journey of the players.

Additionally, this process was applied to my methods to extract data I could then evaluate. For the interviews, I used coding. By using this approach, I could use codes to assign a label to pieces of text from the interview transcripts, allowing me to identify and summarise concepts from my interviews.

Through coding my data and identifying key terms, I was able to create data visualizations. This involves using the data I collected and classified into visual representations. Frey identified two purposes of data visualisation: "(1) to help users understand their data better and easier and (2) to let them discover unknown facts about the underlying phenomena from which data are derived" (2018). With data visualisations, identifying greater themes and trends was possible, while also helping others to better understand the conclusions I reached.

The primary area coding was done in was the Surveys and Interviews, both of which followed the same process seen in **Figure 10.**

Step 1: Initial Reading of Transcripts and Surveys
After all the data was collected, the interviews were manually transcribed and the answers from surveys were digitally typed up.
Step 2: Organisation and Coding of Responses
The responses were organised thematically. Interview transcripts were sorted for key words related to emotions and emotional responses, as well as the descriptions of mechanics. Similar was done with the surveys – except further consideration for the player types.
Step 3: Data Analysis and Findings
The analysis of each response was analysed, resulting in themes, patterns, and categorisations. These themes and patterns were put into Excel to further create data visualisations.

Figure 10 Coding Process

3.6 Research Design

In the starting phase, the goal was to establish the theoretical basis of the research project by comprehensively reviewing the literature on emotions, specifically analysing theoretical frameworks used to define, identify, and classify emotions. The primary objective was to identify how the current study would frame the evaluation method of emotions for the proposed framework of this thesis. Due to the subjective nature of emotions and the absence of a consensus definition, it was crucial to undertake an extensive literature review to obtain a comprehensive understanding of the concepts of emotions.

The literature review encompassed several theoretical frameworks that aimed to define, identify, and classify emotions, including the dimensional, discrete, and basic emotion theories. The Circumplex model of affect (Russell, 1980) was chosen as the theoretical basis for this project. The Circumplex model of affect presents emotions on two axes that intersect on a graph – the x-axis represents the valence (positive and negative), while the y-axis represents the arousal (excitation state). The framework's adoption allowed the project to analyse emotional responses in a structured way, enabling a more in-depth and holistic understanding of the relationship between VR mechanics and emotional elicitation, as well as the precise differences in the participants' affective states.

Furthermore, additional research was conducted in the design area to gain an understanding of emotional design and game design frameworks. The literature review covered games design frameworks, emotional design applied to games, and emotional and affective design outside of games. Additionally, there was further research on how designing for VR is different from traditional gaming mediums. This particular area branched out to reviews and interviews with game developers in the industry, alongside sources such as Steam reviews for VR games from players themselves.

The theoretical basis established in this section was critical for the subsequent phases of the study. Understanding the literature and the theoretical frameworks was necessary for identifying emotions and designing the prototypes in phases one and two.

3.6.1 Phase One

The first phase of the research design, extending beyond the initial groundwork, was focused on discerning emotions provoked by VR mechanics. This was achieved through hands-on engagement with a variety of VR games, akin to the industry practice of testing video games. The intention was to populate the framework by identifying existing mechanics and plotting the affective states they elicited from me. To facilitate this, a questionnaire was crafted to capture my emotional reactions to the mechanics encountered during the playtesting of various VR games. This playtesting approach, mirroring industry practices, provided the foundation for constructing the framework, leveraging the insights gathered from multiple VR gaming experiences.

However, recognizing the potential influence of emotional subjectivity on results, potentially leading to diverse and inconclusive outcomes if extended to others, a pilot study was undertaken. The pilot study served the dual purpose of verifying the emotional conclusions reached by the researcher, as well as gaining an initial understanding of the effects of player types on emotional responses. The primary method of data collection for the pilot study was semi-structured interviews conducted at the end of the play session. Data analysis was conducted during gameplay through observational analysis and video analysis was used if review of certain gameplay sections was necessary. Player types were determined through the HEXAD questionnaire (Tondello et al., 2016).

The pilot study's results provided insights into the participants' emotional responses to the VR mechanics and how different player types reacted to them, which informed the subsequent design of the framework and main study. The findings revealed that the proposed framework was applicable in evaluating the emotional responses of participants to VR games mechanics. The data collected from the pilot study was used to refine the emotional elicitation framework and develop more targeted survey and interview questions for the main study.

3.6.2 Phase Two

With the completion of Phase One and the establishment of a framework for emotional elicitation from VR mechanics, the next step was to apply my framework to the design and creation of two separate VR prototypes. This would allow for a deeper exploration of the framework's performance when involving multiple mechanics and other interfering factors, and a better understanding of the emotions that could be elicited through each design.

The VR prototypes were developed using the Unity game engine. The prototypes were designed to elicit different emotions from participants (tension and calm) and were tested on a group of volunteers who met the inclusion criteria.

The data collection methods for this study primarily relied on surveys after each prototype to evaluate their affective states throughout gameplay. The survey contained the circumplex model of affect for participants to map their emotional states at the beginning, middle and end of the game prototype, as well as questions about their general experience playing the game and specific mechanics with stronger responses. The surveys were designed to gather both quantitative and qualitative data about the participant's emotional responses to the game – quantitative being the precise mappings on the circumplex model.

In addition to the surveys, a short interview was conducted with each participant to verify the understandings reached via the questionnaire. The interviews were semi-structured, allowing for follow-up questions and further exploration of the participant's emotional experiences during gameplay. The interviews were audio-recorded and later transcribed for analysis.

Results were also reached via observational analysis during play of both prototypes. The researcher observed the participants during gameplay, taking note of their behaviours and reactions, and made note of any key observations or insights that could be useful in evaluating the emotional responses elicited by the game. Video analysis was used to support the review of any conclusions reached through observation.

The data was analysed using thematic analysis to identify key themes and patterns in the data. The results of this phase were used to revise the framework and examine its validity, with a secondary goal of further exploring the relationship between player types and emotional responses elicited.

Overall, the Phase Two study allowed for a deeper understanding of the framework's performance when applied to actual design and testing, and provided valuable insights into the emotional responses that can be elicited through VR game mechanics. With the additional insights into the effect of player types, the data analysis also allowed for deeper insight into potential emotional subjectivity that can also occur. The results of this study were used to revise and refine the framework, and to inform future research in the area of emotional design in virtual reality.

3.7 Ethical Considerations

Ethical considerations were addressed in this study through informed consent, confidentiality, and anonymity. Participants were provided with information about the study, and their participation was completely voluntary. Ethics approval was received via BREO application on May 27th, before any studies were conducted.

3.7.1 Avoiding Harm to Participants

To avoid potential harm to participants and triggering any intense negative emotional responses, a survey was conducted before any participant was allowed to partake in the VR testing. The survey used was taken from psychology, known as "Beck Anxiety Inventory" and was used to gauge whether the user had a higher anxiety level and thus more susceptible to triggering an intense negative response.

The Beck Anxiety Inventory is a 21 question self-report inventory to measure anxiety, with multiple choice responses set on a scale from not at all, mildly, moderately, or severely. Each answer is worth a certain number of points – the total is added at the end. It is split into different ranges – Minimal (0 to 7), Mild (8 to 15), Moderate (16 to 25) and Severe (26 to 63) (Beck, Epstein, Brown, and Steer, 1993).

The highest threshold identified in this inventory was the one I set as a limit for participants – i.e. no higher than 25. No participants reached the threshold.

Additionally, steps were taken to minimize the risk for physical harm to participants. I helped participants secure their VR headsets when necessary, and warned participants when they got too close to the walls and tables. While the VR space I mapped for the play area would alert participants when they were getting close to the borders, I included an auditory cue from myself as an extra safety precaution for those unfamiliar with VR spaces. The VR headsets were also sanitized with wipes between each play-session. Players were instructed to wear the wrist straps on the controllers to prevent them from accidentally releasing the controllers. Additionally, I remained present in the room to provide auditory feedback if they came too close to any objects they might collide with.

3.7.2 Informed Consent

To address privacies and ensure the participants were knowledgeable beforehand of what the studies involved, I followed informed consent. "Informed consent entails informing the research subjects about the overall purpose of the investigation and the main features of the design, as well as of possible risks and benefits from participation in the research project" (Brinkmann and Kvale, 2018, p.6). Participants had access to the Participant Information Sheet which introduced what the study involved, as well as a mandatory Consent Form that participants read through and signed before the study could begin. Participants were able to withdraw from the study at any point in time, as well as pause the study for any reason.

3.7.3 Confidentiality and Data Protection

"Confidentiality in research implies that private data identifying the subjects will not be reported" (Brinkmann and Kvale, 2018, p.7). In this thesis, all the data regarding participants is anonymised. At the start of each study session, I informed participants of the anonymisation of their data.

Following the University Research Data Management policy, I will retain my anonymised data for a minimum term of ten years. I will be following the "3-2-1-rule for Backup" recommended by the university. Data will be stored on my university email's One Drive, on my personal computer, and on an external hard drive. Any data stored on my personal devices will be encrypted.

3.7.4 Emotional Design Ethics

There is also the consideration for ethics regarding the manipulation of emotions within games design. Neutral design is non-existent (Hodent, 2020). Some cases of when emotions trick us include scarcity, loss aversion, and fear of missing out. These examples can easily be seen in the real world, with a multitude of examples given by Hodent (2020). For example, scarcity was seen when the pandemic began, with the panic buying of toilet paper. Fear of missing out can be tied to scarcity, with such thoughts as "maybe the toilet paper is going to be gone before I get to the store". Fear of missing out can also be used, and is used, as a sales tactic – "Oh, this sale is about to end. Better buy it now!". Lastly, loss aversion implies that we are more sensitive to potential losses than gains. This phenomenon is especially noticeable in gaming contexts, where features such as streaks or incentives for daily logins and gameplay are prominent examples.

Being aware of these is important in any games design approach. While there will certainly be some form of emotional manipulation, approaching design with the active intention of avoiding a negative impact on the players' experience is a healthy approach to games design and should be considered. This thesis aims to consider more negatively connotated emotions such as fear but does so within an acceptable level. There is also a safety measure in terms of a health survey (Beck Anxiety Inventory) in both studies conducted to ensure the user is not at risk of triggering any negative reactions.

3.8 Summary

In summation, this chapter has outlined the methodology used in this study to develop a design framework for VR mechanics that elicit targeted emotions. This study takes a constructivist philosophy through an affective design lens and uses the research by design methodology. The data was collected through surveys, interviews, and observations. The use of qualitative research is justified by the nature of the research question, and the data was analysed using thematic analysis. Ethical considerations have been addressed, and the participants were recruited using a random sampling technique within the Games Design department at Brunel University. Overall, the methodology used in this study is well-suited to the research question and provided valuable insights into the design of VR mechanics that elicit targeted emotions.

Chapter 4: Framework Exploration

4.1 Designing for VR

Virtual Reality (VR) game mechanics differ significantly from game mechanics on other platforms such as PC, console, and mobile. This is because VR allows for a level of immersion and physicality that is not present in other media. The design process for VR games exhibits both similarities and distinct differences. While developers still create games at their core, the unique immersive nature of VR and the distinctive hardware interface require careful consideration. It's essential to acknowledge that, although some fundamental game design principles apply, VR introduces a novel dimension that sets it apart from traditional platforms.

One major difference between VR mechanics and those in other games is the use of physicality. In VR, players use hand gestures and body movements to interact with the game world, rather than just pressing buttons or clicking a mouse. This physicality can make the gameplay more immersive and can elicit strong emotional responses from players, but it also requires careful consideration of the player's physical abilities, as well as space limitations. For example, in a traditional game, the player might hold a button to walk, while in a VR game, the player would physically walk around, moving their legs. Using a bow and arrow in a VR game requires players to physically draw the bow and aim the arrow, which can create a sense of tension and excitement that is not present in traditional games as your hands mimic the realistic use of a bow. These types of inputs are not possible in traditional games. As a result, this allows for more complex and realistic interactions, but needs to be carefully designed to ensure that they are both engaging and safe for the player.

These considerations extend beyond just interactions, impacting even basic mechanics like movement in a game. For instance, in the VR game *Superhot VR* (SUPERHOT Team, 2017), players physically dodge bullets and hazards, triggering time to advance only when they move. This innovation introduces tension and excitement, demanding quick reflexes and strategy. However, it can also tire players and challenge those with limited play space. This phenomenon highlights the novelty of VR, ushering in new opportunities and frontiers in game design. These factors form a central point of this dissertation, underscoring the unique potential of VR to reshape interactions and mechanics, prompting a deeper exploration of these emerging possibilities.

Another key difference is the level of immersion that VR provides. In a VR game in first person, players are completely surrounded by the game world, which can make them feel as though they are really there. This can create a strong emotional connection with the game and the characters within it. For example, in a VR horror game, players may feel a heightened sense of fear and dread as they explore a dark and eerie environment.

However, while Virtual Reality (VR) allows for an unprecedented level of immersion by mimicking reality, it also demands considerations for affordances. Even the number of interactions available to the player in VR can impact a player's experience. In a traditional game, if the player is in a bedroom, they won't necessarily expect every single drawer in a dresser to open, or every object to be interactable. Due to the heightened sense of presence within the virtual environment of VR, player expectations differ from those in traditional games, leaning towards a greater alignment with reality. When you go into your own bedroom, you know you can open your closet, or move the blanket off your bed. When you go into your own bedroom in VR, these expectations reflect with reality, and thus not conforming can impact immersion.

Furthermore, VR games require special considerations for player comfort and safety. As VR gameplay can be physically demanding and disorienting, developers must take measures to prevent players from experiencing motion sickness or other adverse physical effects. These measures may include implementing comfort settings like adjustable FOV and movement speed, or providing clear visual cues to help players orient themselves in the virtual world. These considerations can also impact the design of core mechanics such as basic locomotion. For instance, smooth motion via joystick navigation can cause more severe motion sickness in some users, leading some VR games to offer multiple locomotion options that players can switch between.

Overall, VR mechanics are different from mechanics in other games because of the unique level of immersion and physicality that VR provides. The design process for VR games also differs, as developers need to consider the different player expectations and inputs of the hardware, as well as special considerations for player comfort and safety. This chapter introduces the design framework this thesis proposes by discussing its creation process.

4.2 Framework Development

To begin with creating a framework, I reviewed existing frameworks and methodologies. Whilst these have been mentioned previously in the literature review of **Chapter 2,** I will retouch on them here before diving into the development of initial design models for my framework. Within the research areas of psychology, affective design, and games design I aimed to combine the understandings from different models to create a piece of my own and began by creating two initial ideas.

I will provide a brief introduction of the models I used in my preliminary designs and elucidate the rationale behind their selection. I will then present the two initial models I devised, along with their respective merits and drawbacks.

Affective Design

From the Affective Design research domain, I chose Norman's levels of emotional design. This framework was proposed by Don Norman, a cognitive scientist and usability engineer, in his book "Emotional Design." Norman's framework identifies three levels of emotional design: visceral, behavioural, and reflective. Visceral design refers to the initial, instinctive response to a product's aesthetics, such as its appearance or sound. Behavioural design refers to the usability and functionality of the product, which can elicit emotions such as frustration or satisfaction. Reflective design refers to the emotional response that a product elicits after use, such as memories or stories associated with it (Norman, 2002;2004;2005). This framework is useful in designing VR mechanics that elicit targeted emotions because it highlights the importance of considering the emotional response at each stage of the design process.

Games Design

One of the most well-known frameworks for games design is the MDA (Mechanics, Dynamics, Aesthetics) framework, proposed by Robin Hunicke, Marc LeBlanc, and Robert Zubek in 2004. The MDA framework provides a structured approach to games design by breaking down the game into three components: mechanics, dynamics, and aesthetics.

Mechanics refer to the rules and systems that govern the game, dynamics refer to the player's interactions with the mechanics, and aesthetics refer to the emotional responses elicited by the game. By analysing a game in terms of these three components, designers can identify how the mechanics and dynamics are contributing to the aesthetics and make adjustments to elicit specific emotional responses from the player.

Comparisons

Each of these two frameworks offers a unique perspective on the design of interactive experiences and the elicitation of emotions. The MDA framework provides a structure for understanding the relationship between game mechanics and player experience, while Norman's levels of emotional design focus on the emotional impact of design choices on users.

While each framework has its strengths, combining them can result in a more comprehensive approach to designing VR mechanics that elicit targeted emotions. By implementing the MDA framework, designers can pinpoint the exact mechanics and systems necessary to evoke the intended emotional response across varying gameplay stages. Subsequently, by integrating the levels of emotional design, designers can assure that their creative decisions harmonize with the targeted emotional outcomes, particularly within the unique context of virtual reality. This convergence of frameworks presents an innovative approach, uniquely tailored to the intricacies of the VR medium.

4.2.1 Creating Initial Models

Figure 11 visualizes the first model, an amalgamation of Norman's and MDA frameworks. This model drew inspiration from MDA's dissection of distinct game levels, leading to the introduction of the categories "Interactions" and "System". "Interactions" encapsulate player actions, while "System" encompasses the game's rules. However, this approach doesn't directly encompass the analytical structure I sought for evaluating the emotional influence of gameplay mechanics and player interactions across various levels, from immediate, instinctive reactions to broader, reflective responses. My adaptation focuses on integrating Norman's principles, thus providing a well-defined framework tailored for VR's unique interactions.

	Visceral	Behavioural	Reflective
Interactions			
System			

Figure 11 Affective Design with Game Design Levels

Figure 12 presents a similar structure to the first model, but it is more grounded in game design terminology. The model is organised into three rows: "What," "How," and "Emotions". The first column, "What," pertains to the game's interactions, encompassing the manner in which a player engages with all game mechanics. The "How" pertains to the system, encompassing the game's rules and mechanics. Finally, the "Emotions" column addresses the emotional response elicited by the interaction with a specific mechanic.

The interactions and system are then categorized into three distinct groups. The first group is "affordances," which includes the actions available to the player. The second group is "signifiers," which refers to the visual cues and hints that guide players when affordances are not clear. The third group is "feedback," which is the game's reaction or response to a player's action. Overall, this model provides a structured way to analyse the emotional impact of game mechanics and player interactions using game design terminology and categorisation to understand the individual components of a game.

	Affordances	Signifiers	Feedback
Interactions			
System			
Emotions			

Figure 12 Games Design

To understand the performance of these initial models, I chose to apply both to *Job Simulator* (Owlchemy Labs, 2016). The results can be found below in **Figure 13** and **Figure 14**.

	VISCERAL	BEHAVIOURAL	REFLECTIVE
INTERACTIONS	- Physically manipulating objects	- Receiving rewards for tasks	- Reflecting on comedic responses
	- Gesturing with hands	- Exploring unexpected interactions	- Understanding engagement and feedback connection
SYSTEM	- Tasks to follow	- Uniqueness of jobs and interactions	- Reflection on humour-driven design philosophy
	- Environment responds to interactions with immediate feedback	- High engagement from experimentation	- Value of diverse interactions for replay-ability

Figure 13 Application of Model One to Job Simulator (2016)

	Affordances	*Signifiers*	*Feedback*
Interactions	- Physically manipulating objects	- Visual and auditory cues for interaction	- Rewards for successfully completing tasks through auditory responses
	- Gesturing with hands	- Objects changing or reacting to manipulation (colours, auditory feedback, etc)	- Positive feedback for interacting creatively
	-Completing tasks	Task Board offers visuals at any point in game with guidance	- Comedic responses for unconventional actions
System	- Game replay-ability due to diverse interactions (Excitement, Satisfaction)	- Unique tasks/interactions for different jobs (Ex Store Clerk – dialogue with customers)	- Goofy physics results in unexpected outcomes(Excitement)
	- Environment responds to interactions (Satisfaction)	-Tasks give auditory cues *and* visual descriptions	- Packing up to player(Satisfaction)
Emotions	Interest, Joy, Excitement, Satisfaction	Amusement, Excitement, Satisfaction	Satisfaction, Joy, Amusement, Excitement
	Affordances	Signifiers	Feedback
Interactions	- Physically manipulating objects	- Visual and auditory cues for interaction	- Rewards for successfully completing tasks through auditory responses

Figure 14 Application of Model Two to Job Simulator (2016)

4.2.1.1 Reflections

During the developmental phase of the initial models, a central question arose: how could the framework effectively achieve the objectives of this thesis? Although the concept of a well-structured table seemed promising, the key challenge lay in unifying design mechanics and comprehending the resultant emotional responses.

Throughout this exploratory journey, it became evident that the first model, which aimed to integrate existing models from various academic research domains, presented certain limitations. The intention was to combine affective design principles with established game design frameworks. However, this approach hindered the application of the models to the intricacies of VR mechanics and also appeared too convoluted to pinpoint where emotions could seamlessly fit in. The complexity of divisions made it challenging to address and evaluate mechanics in a structured manner, preventing the attainment of useful insights.

Upon critical assessment of the two preliminary models, it became apparent that the game design-oriented model emerged as the more practical and promising choice. Organising mechanics according to different gameplay types and levels resonated more effectively than categorizing them solely based on emotional design principles. This model, while laying the foundation for the framework, also revealed the need for streamlining. The revised framework's core focus shifted to the inputs within the game and their consequential emotional impact, placing emphasis on processes rather than intricate categorizations.

This journey illuminated the fact that the initially envisioned integration of external models did not yield the desired practical outcomes. Despite its intellectual appeal, the concept failed to translate effectively into the realm of VR mechanics design. Recognizing this limitation prompted a refined approach, aligning the framework's initial structure with the fundamental processes of game interaction and emotional response. This resulted in a more robust and grounded model, providing a solid starting point for further exploration.

To address the need for concreteness in the design process, attention was directed towards identifying what was missing. With an initial model aimed at comprehending mechanics in games (albeit transitioning to an inputs and outcome structure), which could serve both game evaluation and design, the next step toward creating a comprehensive framework required addressing the necessary processes:

- **Evaluation:** The first challenge was to determine how to effectively identify and understand mechanics in existing VR games, subsequently mapping them to emotional responses.
- **Design:** Building upon the knowledge garnered from the evaluation of VR games, the framework needed to be reversed – initiating with an emotion and progressively moving towards the mechanics that evoke it.

The recognition of this requirement prompted an exploration of the individual components within mechanics that can exert an influence on emotional responses. This exploration, poised for a pilot study, seeks to establish whether distinctions between various aspects of gameplay, such as segregating analysis into Interactions and System, or dividing responses into input/outcome, or even categorizing affordances/signifiers/feedback, are necessary for achieving a comprehensive understanding.

Furthermore, the preliminary models highlighted a perceptible gap between mechanics and emotions, creating a void that hindered the seamless integration of these crucial elements. This disconnection proved to be intricate and could obstruct designers from operating within a tangible design process. This insight triggered a pursuit of an intuitive combination between mechanics and emotions. As a result, the subsequent step involves delving into the exploration of the evaluation process, with a focus on bridging the gap and establishing a harmonious connection between mechanics and emotions.

4.3 Populating Model with VR mechanics

Using the second model from **Figure 12**, I can start by identifying the basic emotions we want to elicit in players through VR mechanics. For example, I may want to elicit excitement, fear, joy, or a sense of accomplishment. By identifying various mechanics and their corresponding emotional responses, I can then work in reverse to develop mechanics that intentionally elicit desired emotions for designers.

To illustrate the process of identifying VR mechanics, I played several VR games and noted down their mechanics and emotional responses. For example, in the game *Superhot VR* (2017), the player is required to physically dodge incoming bullets and objects in slow motion, leading to a sense of excitement and adrenaline rush. In *Keep Talking and Nobody Explodes* (Steel Crate Games, 2015), the player must diffuse a bomb with the constraints of communication with another player who has the bomb manual, leading to a sense of stress and pressure.

Through this process of playing VR games and noting down mechanics and emotional responses, I began to develop a comprehensive list of VR mechanics that elicit targeted emotions. This table of mechanics and emotional responses started out quite specific, which was useful as a starting point, but not useful for designers later on who want to make games of different genres.

With the *Superhot VR* (2017) example, the players must dodge incoming bullets with the consequence being death. However, this is quite specific to the context of the game. Instead, I found a similar instance in another VR game – in *Beat Saber* (Beat Games, 2019), I must dodge bombs during gameplay, with the consequence of losing points and potentially ending my playthrough of a song. Another example comes up in *Blades and Sorcery* (WarpFrog, 2018), in which players dodge during combat using medieval weapons. While all dodging mechanics are in different contexts, the core mechanic is the same – dodge incoming objects in real time, which causes a sense of tension and excitement.

Therefore, after playing through VR games and noting individual mechanics, these were then categorized and grouped to create a comprehensive list of VR mechanics and corresponding emotions to be used in this framework.

4.3.1 Selection of Games

The games were selected by several criteria. The first was genre. To cover a comprehensive variety of game types, seven genres were selected. Within each genre, I created a list of the top five best performing games by gathered the popularity data for each game based on their sales performance on the Steam platform. Steam provides a list of the top selling VR games, which I used to gather data for the top five most popular VR games in each genre. With many games overlapping into various genres, I categorized games into the most relevant genres.

Additionally, I used Steam's user review system to gather ratings and overall sentiment (positive, mixed, or negative) for each game. This helped me filter out some games that were relatively like each other in their sales value. VR games that are exclusive to one platform, such as games only accessible on the Oculus Quest store, were not considered. This was a deliberate choice aimed at maintaining a cohesive focus on mechanics' emotional impact without introducing confounding variables associated with differing hardware interactions.

This resulted in a dataset being collected for the top performing games of the following genres: Action Sport, Simulation, Adventure, Rhythm, Horror, Strategy. I have also included several other statistics for reference, such as the number of reviews, to get a more comprehensive understanding of each game's performance and popularity. The tables of these selected games can be found in **Appendix A**.

4.3.2 Sample Evaluation with Evaluation Criteria

As I evaluated various VR games, my goal was to identify multiple VR mechanics in each game. At first, I relied on Plutchik's (1962) basic emotions to determine the emotional response evoked by each mechanic, and I rated the intensity of the emotion on a Likert scale ranging from 1 to 10. However, I found this approach to be inefficient because the rigid categorization of emotions made it difficult to understand how emotions related to each other and transitioned between each other.

To improve the emotional evaluation process, I utilized the Circumplex Model of Affect previously described in **Chapter 2** and **Chapter 3**. This model became my primary tool for emotional evaluation as it provided a more efficient and effective way to assess emotional responses. With this model, I positioned each VR mechanic as a point on the model and included additional descriptions as needed to clarify their interactions.

I exemplify this process below in the evaluation of the VR game *Job Simulator* (2016).

4.3.2.1 Evaluation of VR game

I will briefly cover the Store Clerk level of *Job Simulator* (2016). The game itself contains four different game modes. The Store Clerk mode involves running a store. On the initial loading into the game, I am met with a small environment I can look around and interact with. There are many different utilities available to interact with. I first tried to interact with any object or surface I could reach. This involved:

- Hot Dog Grill
- Slush-E Machine
- Display Case
- Scanner
- Jumbo Sizer
- Storage Drawers

I found some utilities were hidden and required me to turn a slider to access them, like an oven dial. Others required me to find objects to use them, such as the hot dog grill – hot dogs were frozen in the freezer. Additionally, if you cooked them for too long, they could burn.

Figure 15 Job Simulator (Owlchemy Labs, 2016)

Figure 16 Job Simulator (Owlchemy Labs, 2016)

I identified some of these initial mechanics in a tabular format seen in **Figure 17**, accompanied by brief descriptions to identify how they worked, before making my conclusions on the emotional responses I felt during gameplay (alongside considerations for other outcomes).

Mechanic	Descriptions	Possible Emotional Responses
Grilling hotdogs	Interacting with the Hot Dog Grill involves placing the frozen hot dog on the grill and waiting for it to cook. If the player waits too long, the hot dog will burn and turn black.	The mechanics of cooking the hot dog require the player to pay close attention to the time and avoid overcooking. Successfully cooking will provide a satisfying feeling of accomplishment and joy, while the process of cooking causes anticipation – burning it may cause antic frustration.
Assembling hotdogs	Players can retrieve hot dog buns from a compartment underneath the grill. Players can also pour ketchup and mustard by tilting the bottles upside down over the hotdog.	The realistic performances of placing the hot dog in the bun and pouring sauce on it brings joy and excitement on discovery. The sauce cannot be poured anywhere else though, which can bring frustration.
Using slush-e machine	The Slush-E Machine is used to fill up paper cups with slushie drinks. The player can pull two levers to pour out the beverage, with two flavour options. The mechanics of using the Slush-E Machine involve pulling the levers and aiming the cup correctly to avoid spilling.	The machine provides an endless supply of cups, which can make the player feel like they have unlimited resources. Additionally, the different flavours of slushies, and the ability to mix flavours, may provide a sense of variety and excitement. The player can also use two hands and pull down both levers at once, which can bring an added boost in joy and fun at the discovery.

Figure 17 Identifying mechanics in Job Simulator (Owlchemy Labs, 2016)

While there were emotional descriptions included, I also made sure to map the potential emotions onto the Circumplex Model of Affect. While the table considers a variety of emotional responses and scenarios, the point identified on the model will stick to the core emotional reaction I felt each mechanic embodied. This process can be seen in **Figure 18**.

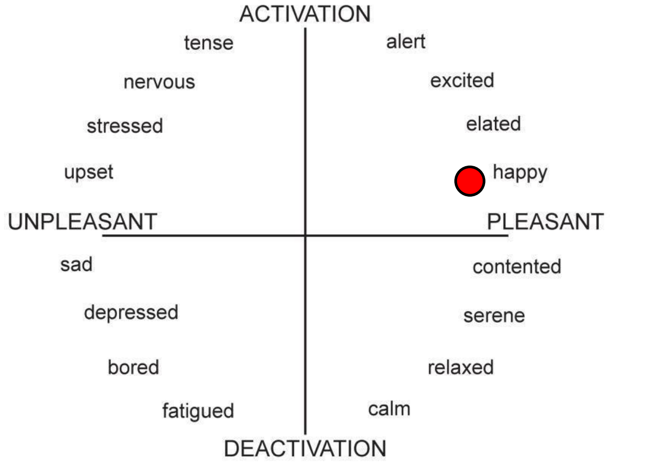
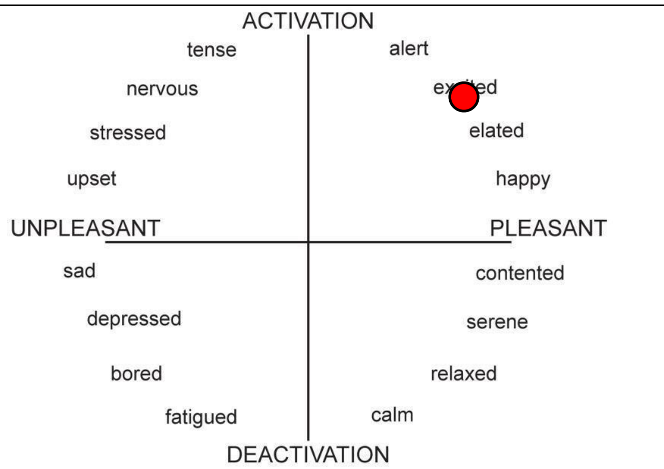
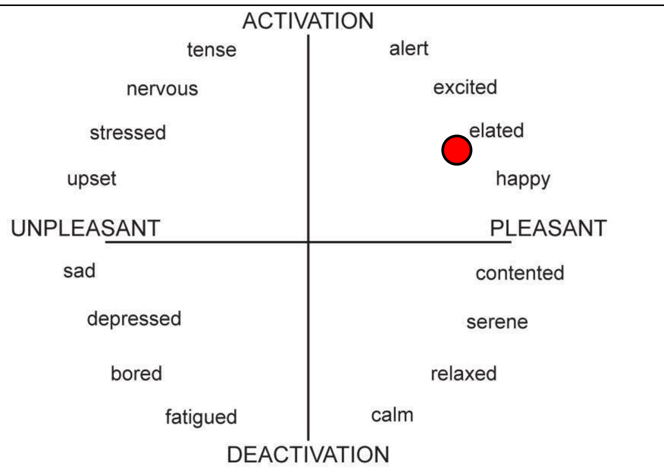
<table>
<tr><th>Mechanic</th><th>Possible Emotional Responses</th></tr>
<tr><td>Grilling hotdogs</td><td>
</td></tr>
<tr><td>Assembling hotdogs</td><td>
</td></tr>
<tr><td>Using slush-e machine</td><td>
</td></tr>
</table>

Figure 18 Mapping to the Circumplex Model of Affect

While these small examples cover just a few of the mechanics I ran into when playtesting this game, the game mode itself also involves multiple tasks to go through. I set myself a time of at least 15 minutes each game to properly sample the mechanics offered in the game. More information on the tasks and gameplay can be found in **Chapter 6**, as this game mode was the chosen example for the Pilot Study conducted.

However, knowledge of the slush-e machine performance is not very helpful for informing the design of VR mechanics in other game contexts. Instead of relying on specific examples like those in **Figure 18,** common mechanics were identified, grouped together, and exemplified by overarching mechanics. **Appendix B** presents summarized mechanics derived from the playtesting results. These mechanics, identified from shared affordances and interactions, and observed VR games, will inform the design of two prototypes in **Chapter 5**. Each summarized mechanic contains the examples from the VR games I played to help with clarity, and also serve as points of reference for design ideas and directions on how to use the main mechanic. Each specific example also still contains the variety of emotional responses, allowing for further tailoring from understanding the performance of other mechanics within that system.

4.4 Confirming the Results (Pilot Study)

Despite the detailed analysis and evaluation of VR mechanics and their emotional impact, there is still a subjective element involved in the identification of emotions. To validate and verify the results obtained from the initial analysis, a pilot study was conducted with a small group of participants to assess their emotional response to a VR game with specific mechanics.

The pilot study involved a sample of 19 participants who were asked to play the VR game *Job Simulator* (2016), with different mechanics identified by myself. After the gameplay session, participants were interviewed to discuss and to understand more the emotions elicited by individual mechanics.

The results of the pilot study provided evidence that the initial analysis was indeed accurate in identifying the emotional impact of different VR mechanics. However, it also highlighted the subjective nature of emotional responses and the need for a refined framework that considers individual differences with some sort of measure.

With the pilot study also delving into player types, however, this measure was ideally a good starting point on attempting to classify the different emotional responses. With limited data from the pilot study, drawing conclusions with player types would have to wait for the main study results.

Based on the findings from the pilot study, the initial model for the framework was refined to better capture the emotional impact of VR mechanics across and individual differences and variations. The refined model was used to create two VR prototypes. The final framework of this thesis and its breakdown can be found in **Appendix D**. Additionally, the format has been adjusted for use as design patterns in **Appendix E**.

A comprehensive examination of the pilot study data and its results can be found in **Chapter 6**, **Chapter 5** will delve into the design process of the two VR prototypes utilizing the updated framework.

Moving forward, I employed the improved framework to design two VR prototypes, which were then developed in the Unity game engine. These prototypes served as test cases to evaluate the effectiveness of the framework's design during the main study's playtesting phase. This design and development process will be covered in the next chapter.

4.5 Deconstructing Framework so Far

To gain a comprehensive understanding of how to design games using the current model of the framework, it is essential to understand its components, and learn how to expand the framework further. To achieve this, several design sequences have been created and are explored in the following sections.

4.5.1 Identifying Terms

Upon reflection of my progress in developing the VR mechanics and creating structured models for the framework, I realized that certain terminology required further clarification. Specifically, I encountered some uncertainty with regards to the terms "affordances," "mechanics," and "interactions." These discrepancies were not limited to game design, but also appeared in other research areas such as UI design. To ensure a clear and consistent understanding of these terms going forward, I have provided summarized definitions of each below.

Affordances: Within the context of game design, affordances encompass the inherent potentials and indications of how players can interact with game elements or environments. They outline the spectrum of possible actions that objects or environments invite based on their attributes and surroundings. For instance, a ladder affords climbing, a button affords pressing, and a door affords opening or closing. While affordances provide the foundation for interactions, they aren't solely the focus of design due to their inherent breadth and autonomy.

Mechanics: Mechanics, on the other hand, act as the orchestrated array of affordances available to players. Mechanics are the rules and systems that govern how a game is played. They determine the player's available actions, the rewards and penalties for different choices, and the overall structure of the gameplay experience. These mechanics can group shared affordances under the same system, like the ability to open various drawers. Crafting an experience solely around affordances might be overly diffuse, hence mechanics serve as the bridge that orchestrates these affordances into cohesive and structured interactions. Mechanics streamline gameplay possibilities, thereby allowing for a more coherent player experience.

Interactions: Interactions are the points at which players interface with mechanics, triggering and realizing the potential actions offered. They encapsulate how players engage with the game world, fellow players, and inanimate objects.

Mechanics foster the opportunities for interactions, and it's through interactions that players translate these possibilities into tangible experiences. An important distinction to note is that not all mechanics demand direct interaction – some, like locomotion mechanics, don't necessitate direct manipulation of game components. Take, for instance, the dodging mechanic in *Superhot VR* (SUPERHOT Team, 2017): it involves player movement but not direct manipulation of in-game elements. This can also be seen in a majority of combat-oriented games, where the movement system encompasses a range of actions like dodging, crouching, leaning sideways, and a multitude of other physical manoeuvres imaginable.

Therefore, tailoring emotional game responses hinges on shaping the mechanics themselves, enabling player interactions that foster emotional connections. This thesis centres on crafting these mechanics in VR games. Here, I explore the nuanced interplay between designing mechanics, influencing player emotions, and respecting player agency, aiming to control player states of mind within the realm of design influence.

4.5.2 Process of Designing Individual VR Mechanics

The following paragraphs explain the design sequence depicted in **Figure 19** and how it can be used to develop games by leveraging the table of VR mechanics and emotional responses. The table of VR mechanics and emotional responses, found in **Appendix B**, was all generated from the process exemplified previously in **Figure 17** and **Figure 18** – playtesting existing VR games. This design process will make up the core of the framework.

The sequence outlines the steps involved in using the table, starting with the selection of an emotion from the Circumplex Model of Affect. As shown in **Figure 19**, the chosen emotion is Afraid, which has a negative valence and positive arousal, placing it in the top left quadrant. Next, designers refer to the VR table of mechanics in **Appendix B** created for this framework and choose a mechanic that elicits the desired emotional response.

Essentially, I formulated the game mechanics by expanding upon the specific mechanics I identified through my playtesting of existing VR games. For instance, **Figure 19** employs the mechanic of opening a closed space like a closet or chest, and triggering an unforeseen outcome, such as a bat darting out or a goblin jumping out of a chest. However, these specific mechanics, such as opening a closet with a bat or opening a chest with a hidden goblin, may not be practical for game designers due to their specificity. Thus, the framework encompasses mechanics that have the same intentions, and broadens the scope to become applicable to any scenario, thereby enabling designers to work with the mechanics for any game concept they have in mind. This can be seen more in **Chapter 5** with the design of the prototypes' mechanics using the same process.

After the mechanic has been chosen – *e.g.* opening an object – then the mechanic is adjusted to fit into the *designer's game*. This will require further input from the designer depending on the context of the game and what specific interaction would be appropriate. Once the mechanic is decided upon, it is implemented and tested within the implementation cycle before the designer arrives back to the start.

This framework pertains to the design of discrete mechanics, which are brief instances in a game. However, this does not imply that it cannot be employed for longer game instances. Nonetheless, this approach has not been extensively tested for longer gameplay segments. To utilize the framework for designing gameplay sequences, users can select the emotions that they wish to evoke by choosing each emotion as a point on the Circumplex Model of Affect, connecting and numbering the points in the desired sequence, and designing the mechanics accordingly. This would necessitate some degree of gameplay guidance by the designer. **Figure 20** provides an example process of designing an individual mechanic.

For further reference on how to use the framework with its finished design revised after the studies, refer to **Appendix D** for general instructions, or **Appendix E** for design pattern examples.

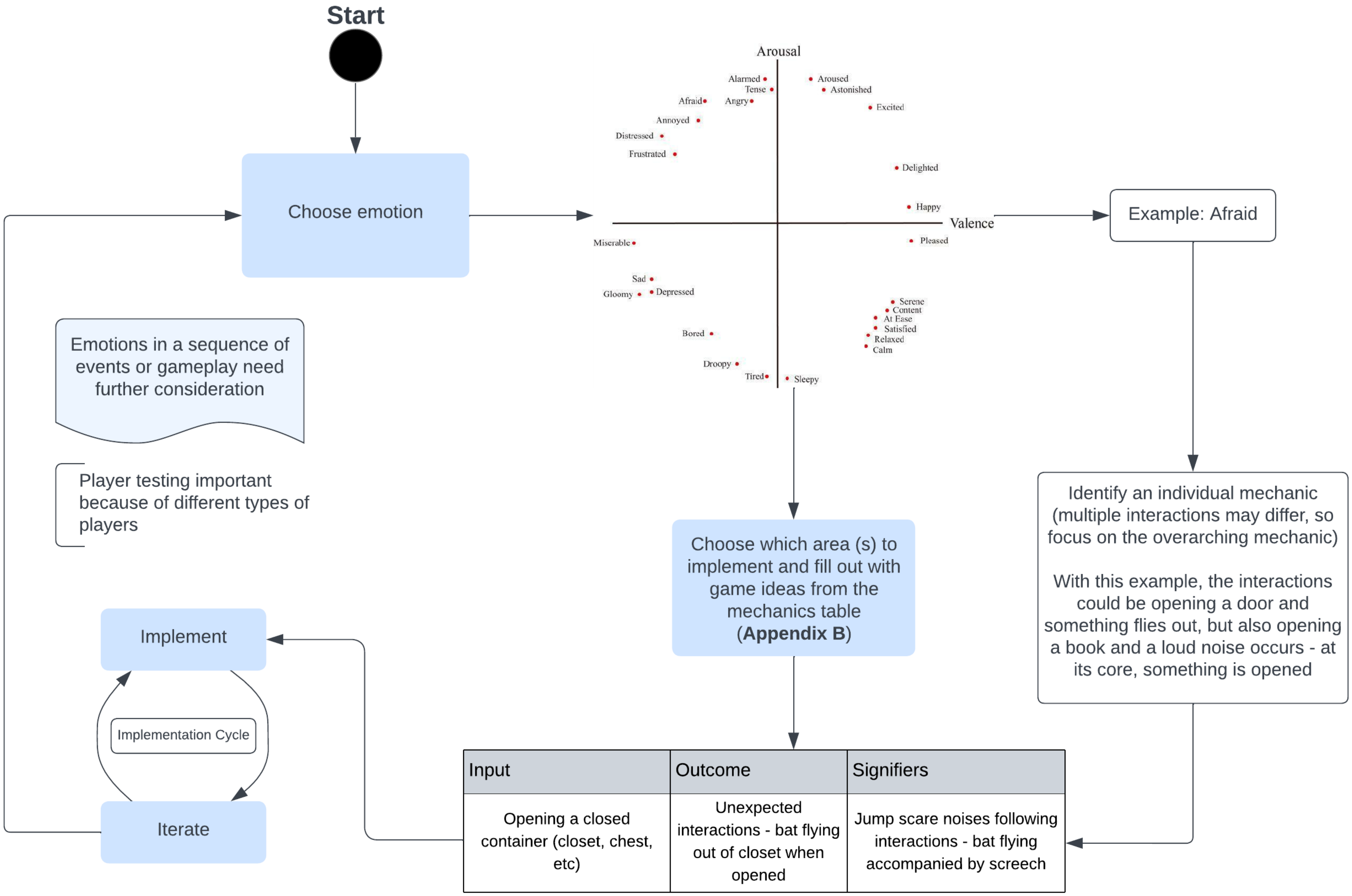


Figure 19 Process of Designing a VR Mechanic for Specific Emotional Response

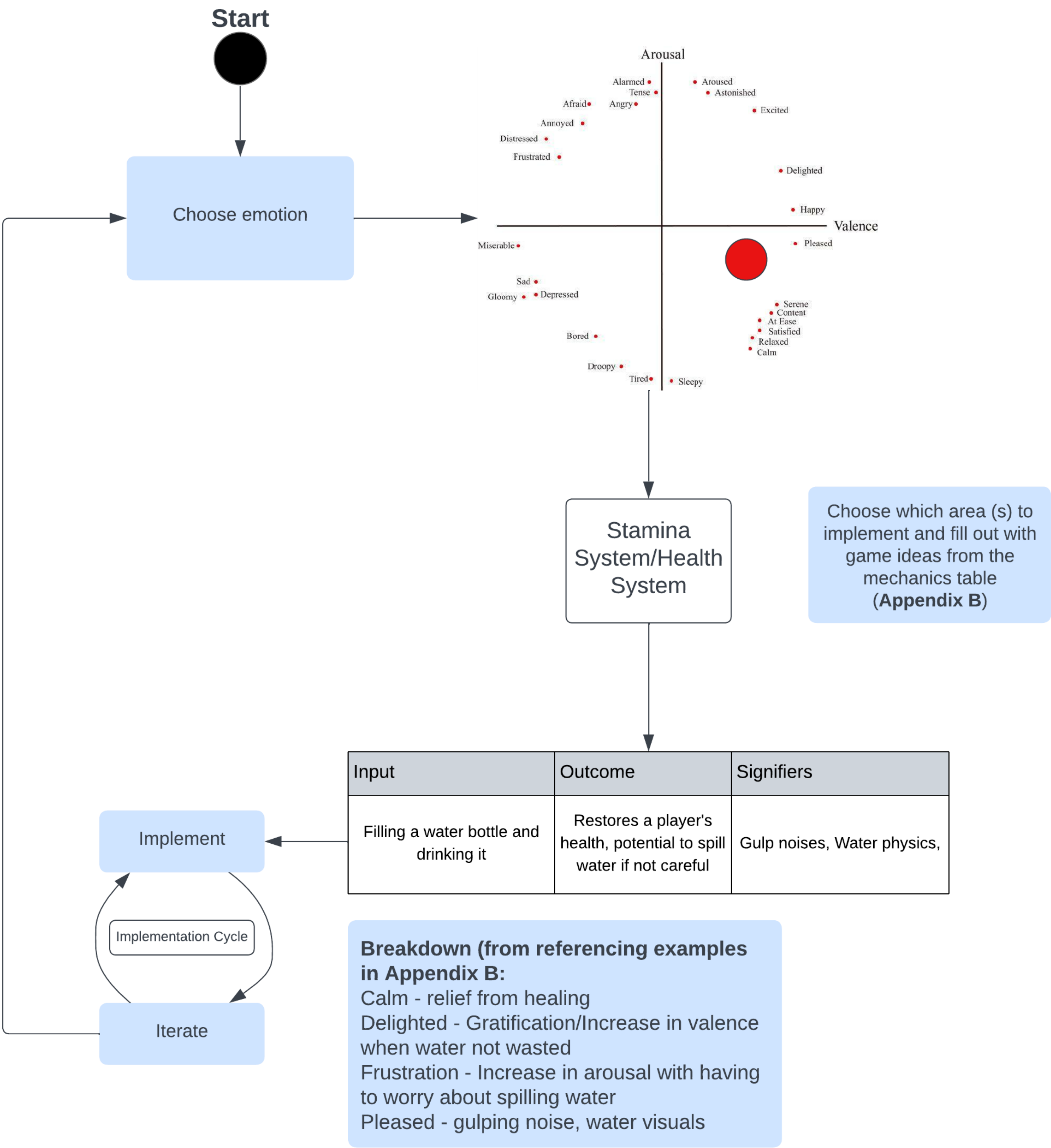


Figure 20 Example of Design of Individual Mechanic

4.5.3 Evaluating Games

At the heart of this framework lies the table of VR mechanics and their corresponding emotional responses. Although this table was initially filled with data from my playtesting of VR games, it is not limited to just that. An important objective of this framework was to allow designers to provide their own input and feedback. This process can be seen in **Figure 21.**

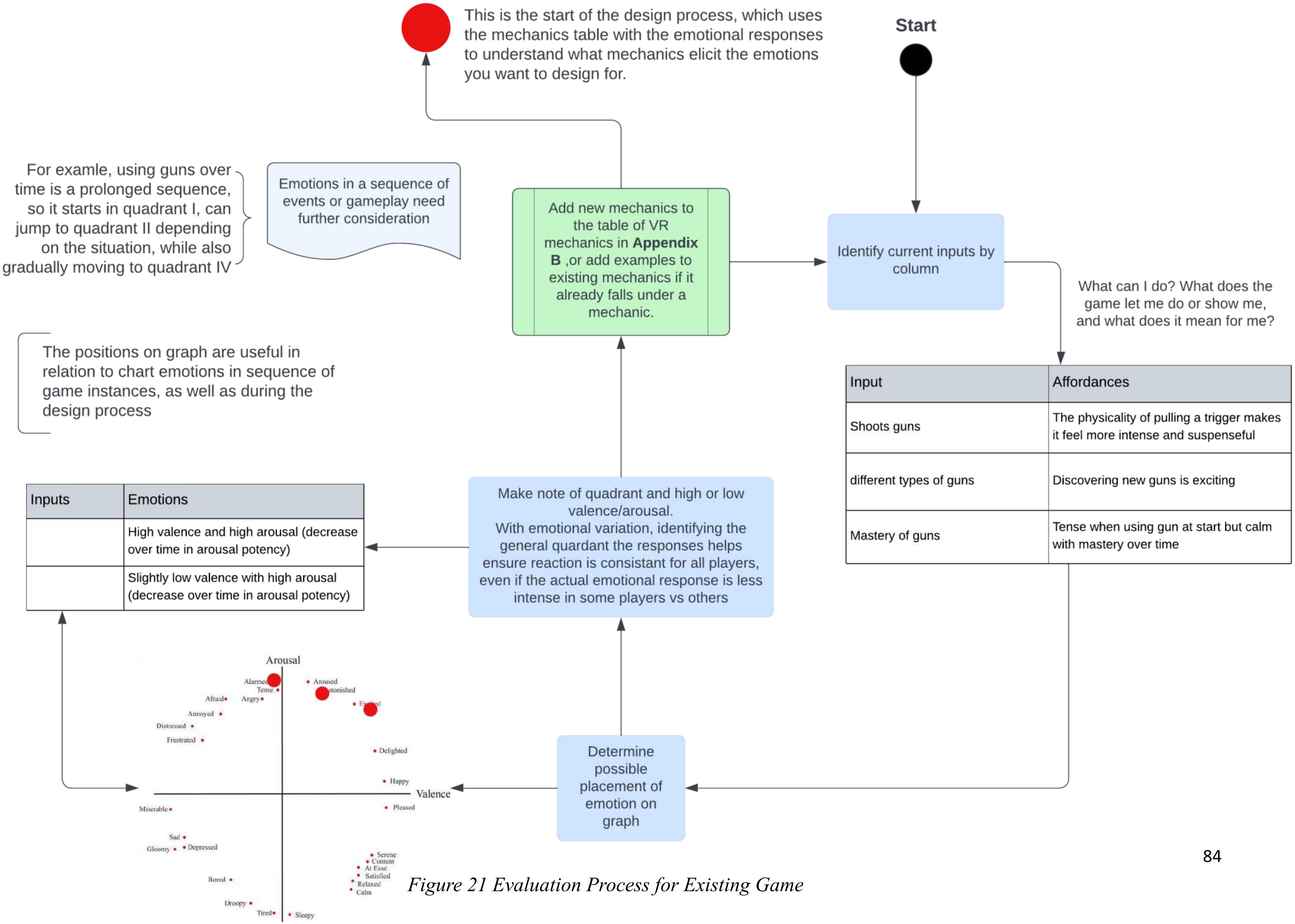


Figure 21 Evaluation Process for Existing Game

4.5.4 Combination of Processes

The design and evaluation are essentially the pair of the core loops in this framework – to populate the framework we need to evaluate games, while to design VR mechanics we utilise the evaluations.

The structured combined approach can be broken down into the following steps, with different starting steps depending on if you are designing VR mechanics to elicit targeted emotions, or playtesting VR games to identify VR mechanics and the emotions they elicit:

Start here for Design

1. Define the desired emotion: The first step is to identify the specific emotion you want to elicit in your players.
2. Identify the gameplay mechanics: Once you have identified the emotion you want to elicit, you need to identify the gameplay mechanics that can trigger that emotion. You can refer to the table provided in **Appendix B**.

Start here for Evaluation

1. Analyse the mechanics: Identify the gameplay mechanic/s
2. Analyse them to determine how they elicit the desired emotion *(referring to* ***Appendix B*** *if any similarities)*

3. Prototype/Playtest/Implement and playtest *(Different purposes for Design vs Evaluation*)

   Evaluation: This will help determine if the mechanics successfully evoke the intended emotion.
   Design: This will aid in the creation of a game that effectively elicits the designer's desired emotional responses in players.

1. Refine and iterate: Based on the feedback from playtesting and development, refine and iterate the mechanics until they effectively elicit the desired emotion.
2. Measure player emotions: Finally, to measure player emotions, you can use the psychological model used in this framework, the Circumplex Model of Affect.

By following this structured approach and format, designers in the VR industry can create mechanics that are specifically designed to elicit targeted emotions in players.

4.6 Summary

Designing Virtual Reality (VR) games involves unique considerations due to the immersive and interactive nature of the medium. VR offers a heightened level of physicality, which can be leveraged to create powerful emotional experiences. To create VR mechanics that elicit targeted emotions, it is important to understand the principles and frameworks that underpin affective game design.

Frameworks from different disciplines, such as game design and affective design, can be used to guide the design of VR mechanics that elicit specific emotions. For example, the MDA (Mechanics, Dynamics, Aesthetics) framework for game design proposes that game mechanics should be designed to create particular dynamics, which in turn should evoke specific aesthetic experiences in players. Norman's levels of emotional design for affective design propose that successful design should cater to the visceral, behavioural, and reflective levels of emotional experience.

In this thesis, I propose a framework for VR mechanics that elicit targeted emotions, drawing upon these different frameworks in the design process. My framework consists of different game elements (affordances, signifiers, feedback) mapped to different game levels (interactions and system). The mechanics refer to the actions players can engage in within the VR environment.

To create the framework, I conducted extensive research by playing various VR games and recording the mechanics used as well as the emotional responses they elicited. By analysing and extracting the individual mechanics from different VR games, I was able to identify commonalities and create a comprehensive table of generalized mechanics and their corresponding emotional responses found in **Appendix B**.

However, I also acknowledge the subjectivity in emotional experiences and that different players may have different responses to the same mechanics. Therefore, a pilot study was conducted to verify my initial findings, which involved a small sample of participants playing an existing VR game and noting their emotional responses. I used the results of this study to refine and revise the framework. The exact revisions can be found in **Chapter 6** with the results of the Pilot Study. The next chapter will discuss the design and development of two VR prototypes.

Chapter 5: Design of Prototypes

5.1 Introduction

In this chapter, I will exemplify the design and development process of two separate VR prototypes created using the framework outlined in the previous chapter. The initial design of the prototypes was guided by using the evaluations of emotional responses to different mechanics in existing VR games. This chapter begins by explaining the emotions chosen for the focus of each prototype, followed by an overview of the two prototypes and the measures they aimed to evaluate. Furthermore, I discuss how I designed the mechanics using my proposed framework, and thus refer to the evaluated VR game mechanics table in **Appendix B** and their corresponding emotions. Finally, I break down the development process of each prototype, providing detailed walkthroughs for a comprehensive understanding.

5.2 Choice of Emotions and Prototype Overview

In this study, two distinct emotions were deliberately chosen as the focal points for the prototypes: calm and tense. This selection was underpinned by multiple compelling reasons. The initial goal of this research was to investigate the potential of VR for addressing mental health concerns, particularly relating to anxiety and depression. This orientation naturally led to the exploration of emotions tied to such states – for instance, the examination of negative emotions like tension arising from anxiety, as well as the creation of tranquil and soothing experiences to alleviate these feelings. Thus, these two emotions were resonant with my early objectives.

Moreover, these chosen emotions offer inherent dichotomies. Beyond occupying opposing positions in the arousal spectrum according to their quadrant placement in the Circumplex Model of Affect, they also stand in stark contrast in terms of valence values. This strategic selection enabled me to gather robust data on emotions with distinctly contrasting qualities. Additionally, it opened avenues for delving into potential transitions between these emotional states. By exploring the potential emotional journeys between the two quadrants, the research sought to unravel the complex emotional dynamics generated by mechanics, providing insights into players' emotional trajectories.

Additionally, I wanted to look at emotions from two opposing quadrants from the Circumplex Model of Affect. Tension contains a negative valence and positive arousal, placing it in the top left of the Circumplex Model. Calm contains a positive valence and negative arousal, placing it in the bottom right of the Circumplex Model. By choosing two contrasting emotions, I can explore the differences between emotions of contrasting values, as well as the relationship between the two.

Each prototype was designed to incorporate several interactions and measures to explore different aspects of emotion elicitation. Prototype One primarily focused on eliciting calming emotions, while prototype two focused more on emotional states of tension. To understand how effective the mechanics I designed with regards to eliciting these emotions were, and explore the effects of different types of mechanics, I identified several measures for each prototype whose performance would be explored during the main study through playtesting.

5.2.1 Prototype One Considerations

Prototype One was dedicated to exploring the emotional reactions provoked by physics-based interactions in a confined setting. Its design encompassed not only the mechanics based on physics but also considered the consequences of the closed environment and the absence of essential tools or skills that necessitate mastery. By enabling every element in the environment to be interacted with, the goal was to scrutinize the emotional impact of various interactions, comparing their effects and examining the role of signifiers. Initially, the focus was on physical signifiers, which were later contrasted with the performance of audio-based signifiers in Prototype Two. Additionally, the intention was to investigate how the emotions of players are influenced in a closed environment, where they navigate in real-time physical environment, rather than relying on locomotion methods such as smooth movement or teleportation.

The evaluation measures used in Prototype One can be found in the following listed format, considering not only the physics-based interactions but also various aspects of the player experience. These measures encompassed:

1. Influence of Closed Environment: Investigating how the immersive experience of being in a closed environment affects the player's emotions and sense of presence.
2. Strength of Interactions: Assessing the level of engagement and satisfaction derived from interacting with different objects, considering their physics properties, and expected performance.
3. Impact of Signifiers: Analysing the effectiveness of visual and auditory cues in guiding player actions and conveying information within the virtual environment.

By focusing on these measures, Prototype One aimed to provide insights into the design of VR mechanics that effectively evoke calm emotions within a physics-based system comprising various mechanics and a closed environment.

The first measure focused on creating a closed space within the virtual environment, where the player could navigate without the need for teleportation or extensive movement using the controller. This design aimed to minimize required movement to align with the player's real-life environment. By confining the player within this smaller space, the intention was to foster a sense of containment and direct their attention towards the objects and interactions within the room. Additionally, the level of immersion was considered as a potential factor to measure during playtesting.

Simultaneously, this prototype also aimed to explore the emotional responses evoked by physics-based interactions within a closed environment. The development process began with the conceptualization of the environment and the objects within it. The environment was designed to create a sense of familiarity and comfort, contributing to the overall calm emotion targeted in this prototype. As was found through other VR games and experiences from VR developers, the best design approach was to ensure *everything* in the level was interactable. Also, many VR games focus on physics-based interactions, which therefore influenced this as a measure to further explore. This prototype aimed to emulate such experiences.

Regarding the difference between types of interactions, this was chosen as a secondary measure tied to general physics-based interactions. The reason this measure was chosen was because of some initial observations during the pilot study. Several participants were particularly fascinated by two separate mechanics.

One of those was the slushie machine, which had two handles with two separate slushie colours: blue and pink. Several participants were fascinated by the options for available interactions with this machine – they could use both hands and pull both levers at the same time, watching the slushie pour into cups underneath, or they could mix both colours into one cup and watch it turn purple.

Alternatively, other participants were fascinated by the "Jumbotron", which let players put any item on the flat surface of the machine. When they pressed the button to activate the machine, it would make whatever objects were on the machine jumbo sized.

By understanding the potential heightened responses from players with these two interactions, I decided to try to create more design variety within the physics-based interactions to try to emulate such differences.

Lastly, the consideration of signifiers as measures stemmed from a collaborative approach between Prototype One and Prototype Two. This decision was influenced by personal experiences playing VR games, which showcased a wide range of methods for explaining controls and instructions to players. Some games utilized diegetic AI placed on the player's virtual hands or controllers, along with displaying additional information like health status, as seen in **Figure 22** from *Half-Life: Alyx* (2020). Conversely, other games incorporated objects within the environment to provide instructions, as exemplified by *Job Simulator* (2016) in **Figure 23.**

Figure 22 Hand Controls in Half-Life: Alyx (2020)

Figure 23 Task Board with Guiding Images from Job Simulator (2016)

5.2.2 Prototype Two Measures

Prototype Two was designed to explore the emotional responses associated with specific mechanics in VR rather than the explorative interactions of Prototype One, with a primary focus on using a bow as the central tool. In addition to the bow mechanics and the mastery that accompanies such tool-based mechanics, this prototype also investigated the effects of an open environment, the presence of signifiers contrasting Prototype One, and the impact of various locomotion options.

Overall, the measures evaluated in Prototype Two encompassed the following aspects:

1. **Locomotion:** Exploring the emotional responses associated with teleportation locomotion and smooth movement as a means of player movement within the virtual environment. Either option is available for all players. This is tied to a secondary measure regarding the emotional impact of an open-spaced environment versus closed space of Prototype One.
2. **Mastery and Skill Development:** Investigating how the process of mastering a specific tool, in this case, the bow, affects the player's emotions and overall engagement.
3. **Influence of Signifiers:** Assessing how auditory-only cues guide the player's actions and convey information in an open environment.

By incorporating these measures, Prototype Two aimed to provide insights into designing VR mechanics that evoke tense emotions within an open environment, utilizing bow mechanics, mastering skills, and employing two locomotion options.

The first of these measures, locomotion, is a core principle in any VR design process. While the most accessible and arguably most used locomotion option involves a form of teleportation based on where the player points their controller (explained more in **Chapter 2**), another option that has been used is smooth motion. This involves using the joystick on the controller to move around, like movement using a controller via console games. The drawbacks of this locomotion in VR is the often accompanied side effect of motion sickness, affecting even the most seasoned VR players. However, for shorter playtimes, smooth locomotion is viable. This prototype aimed to explore the preferences of players between the two motions, and how it affects their play experiences.

The second measure was chosen as a direct counter to the physics-based interactions. While Prototype One focused on the use of the player's "hands" to be able to interact with every object possible, Prototype Two focused on a bow as the main mechanic. To progress through the prototype, the bow is the core principle of the gameplay, and thus the mechanic is focused on tool-based gameplay, rather than a physics-based system. This measure was chosen to explore the potential effect of lack of affordances to the player when only one tool is the focus of the gameplay, but also dive into the third measure – mastery.

While delving into the topic of mastery itself would require much more extensive exploration, the objective of this prototype was to provide a preliminary glimpse into the introduction of a tool within VR. In many VR games, tools play a central role in gameplay mechanics. For instance, action-oriented VR games often employ guns as the primary means of defeating enemies and progressing, as seen in titles like *Arizona Sunshine.* Therefore, it becomes crucial to consider how these tools can impact players and how mastery over them can influence the overall player experience.

However, in this prototype, the bow was specifically designed to automatically load arrows when the bowstring was pulled back, aiming to minimize the difficulty of using the bow. The intention behind this design choice was not to create a tool that was exceedingly challenging to master, but rather to focus on understanding the concept of mastery itself.

Lastly, the inclusion of signifiers in this prototype was intended to specifically investigate the effect of solely audio-based signifiers. The inspiration for this choice stemmed from the findings of the pilot study conducted in the game *Job Simulator* (2016)*,* where players were able to comprehend their tasks without relying on the task board (in fact, some participants didn't even notice the task board until later stages of gameplay). Moreover, the only instances of confusion with tasks arose when participants encountered difficulties with the controls, rather than understanding the task itself.

As a result, the decision was made to experiment with an audio-only signifier system for the hunting tasks in Prototype Two. This approach was undertaken solely to explore the effects of the absence of accompanying visual cues, to gain insights into the potential impact on player comprehension and engagement.

5.3 Development Process

The development process of each prototype involved several stages, including conceptualization, design, implementation, and iteration. Throughout the development process, careful attention was given to integrating the selected mechanics, creating immersive environments, and ensuring a seamless user experience. This PhD focused on developing game prototypes; I utilized existing assets from the Unity Asset Store to aid in development.

Once the mechanics were decided upon, I began the development process by making a blockout of each prototype, placing the objects where they would belong with placeholder models. Once I had a general idea of the layout, I begin to look for the assets I would need through the Unity Asset store. A comprehensive list of all assets used can be found in tabular format under **Appendix C**. This table showcases the names of the assets, an image of the asset, and a link to the asset on the Unity Asset Store.

For iterative development and testing, I connected the Quest 2 VR headset directly to Unity on my laptop. This streamlined the process, letting me playtest the prototype seamlessly within the VR environment to ensure smooth interactions.

5.3.1 Prototype One Development

The development process began with the conceptualization of the environment and the objects within it. The environment was designed to create a sense of familiarity and comfort, contributing to the overall calm emotion targeted in this prototype.

The implementation of physics-based interactions required the creation of realistic object behaviours and responses to player interactions. Each object in the bedroom setting was carefully assigned physics properties, such as weight, texture, and collision, to ensure a lifelike experience. The interactions were designed to be intuitive, allowing players to pick up, move, and manipulate objects in a natural and engaging manner. I decided to use an existing tool from the Unity Asset Store to help. The physics system for VR interactions I used was called *Hurricane VR – Physics Interactions Toolkit* (Cloudwalkin Games, 2020). With my knowledge of coding, I was able to implement interactions in VR through this toolkit and further adjust properties and interactions, such as the poseable grip of the player's VR hands on different objects. This allowed me to chose any asset I wanted from the Unity Asset store, and then make the object interactable through the toolkit.

Additionally, through *Hurricane VR* (2020), I was able to record the hand poses with my VR headset for every custom item I added. For example, for a broom found within the room, I was able to record a custom hand pose for both the left and right hand. Through the customization of *Hurricane VR* (2020), I was also able to make the broom be grabbable with both the left or right hand or using both hands at the same time.

In parallel, the closed environment aspect was integrated into the prototype in a much simpler approach. This involved designing the boundaries of the virtual space to match a smaller room scale environment, which primarily involved myself playtesting repeatedly to ensure the scale was small enough to fit within the boundaries of the playtesting room environment.

Throughout the development process, iterative testing and refinement were conducted to optimize the emotional impact of the prototype. Screenshots taken from the prototype can be found in **Figure 24** and **Figure 25.**

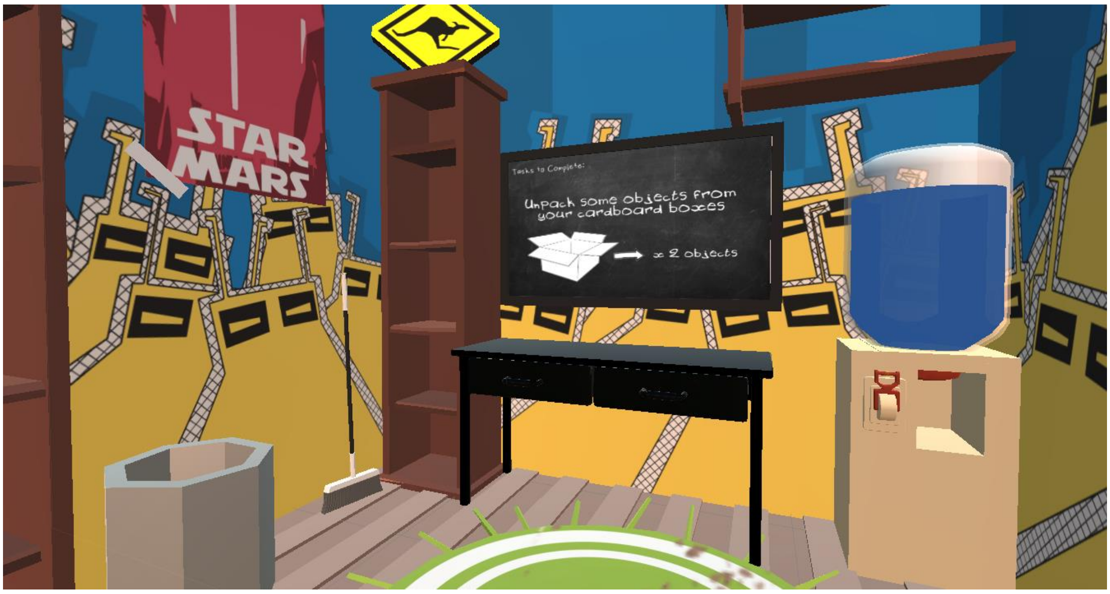


Figure 24 A Screenshot of Prototype One in Unity

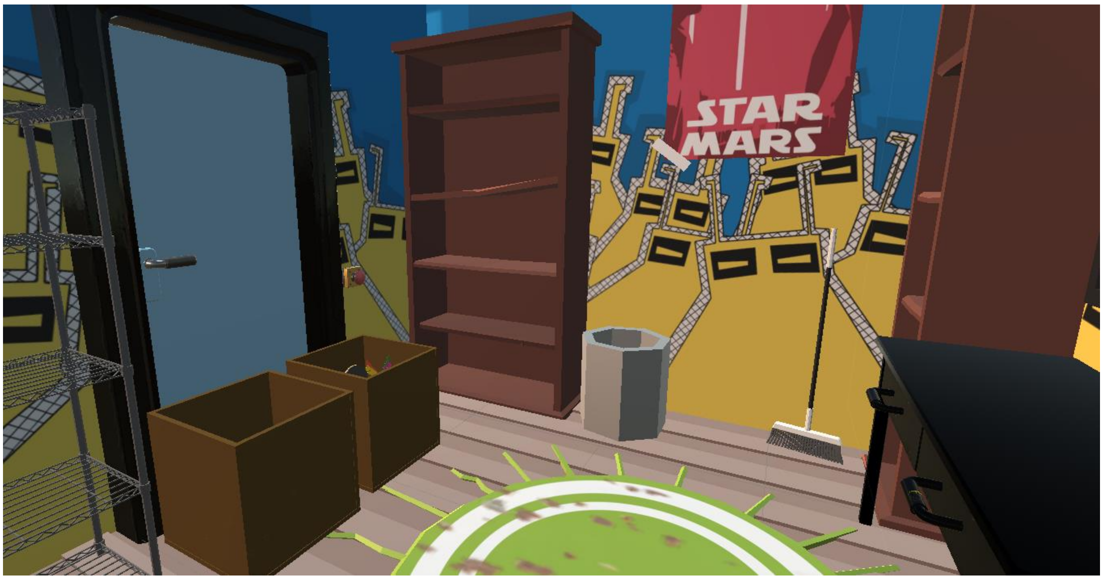


Figure 25 Second Screenshot of Prototype One from Unity

5.3.2 Prototype Two Development

The development process began with the creation of an expansive and visually captivating environment that evoked a sense of exploration and adventure. I create a forest with some small clearings, and a cabin in the centre with a small practice range and shooting targets.

The implementation of bow mechanics involved designing the bow with a physics system for the arrows to realistically perform to players' expectations. Therefore, *Hurricane VR* (2020) was used to create a workable bow. Attention was given to the realism of the bow's behaviour, including drawing the string, arrow trajectory, and impact on the virtual environment. However, instead of physically grabbing arrows and loading them, once a player pulls back the bowstring, an arrow will automatically spawn on the bow. This was due to mastery issues that were encountered with alternative options during playtesting. Due to the smaller scale of this prototype, thoroughly testing mastery would be impossible. To mitigate difficulties players could face and potentially hinder the start of their experiences, I created this alternative that was more user-friendly to get accustomed to. This was particularly vital for those who had zero familiarity with VR – my goal of these prototypes was not to create a difficult game that required a high level of mastery, but to explore surface level mastery with new tools in VR.

In addition to bow mechanics, the mastery aspect was integrated into Prototype Two as progressively more difficult hunting tasks, challenging the player's skills and requiring them to demonstrate different levels of skill with the bow. The tasks were carefully structured to create a sense of accomplishment and build a connection between the player's increasing proficiency and their emotional state.

To facilitate player movement within the open space, teleportation locomotion was implemented, allowing players to navigate the environment with ease. This choice aimed to enhance the sense of presence and minimize the potential for motion sickness, enabling players to fully engage with the hunting tasks and emotional experiences. However, smooth movement was also implemented via the joystick on the controllers. These two movement options were explained with the audio signifiers at the start of the game, allowing players to explore the two and choose their preferred options. This was done to explore the effect of two separate locomotion options on the player's performance and emotional state.

Like Prototype One, iterative testing and refinement were conducted throughout the development process of Prototype Two. I carried out constant playtesting which played a crucial role in fine-tuning the bow mechanics and determining the most comfortable approach to loading the bow.

Screenshots taken from prototype two, showcasing the firing range, forest map, and the rabbit, can be found in **Figure 26, Figure 28,** and **Figure 28**.

Figure 26 Cabin and Firing Range

Figure 27 Forest Map

Figure 28 Rabbit in the Forest

5.4 Selection of Mechanics from the Evaluated Table

To inform the design of the prototypes' mechanics, I followed the framework of this thesis.

To begin, I referenced the design process in **Chapter 4**, by beginning with selecting an emotion in the Circumplex Model of Affect. This process is for designing individual mechanics, so it will be followed for each separate mechanic of both prototypes.

5.4.1 Prototype One Mechanics Design

Since this prototype is focused on calming emotions, I began with emotions that fall in the same quadrant on the Circumplex Model of Affect, which can be seen circled in **Figure 29**.

For ease of view, I found a more readable and clear depiction of the circumplex model of affect (Seo, and Huh,2019).

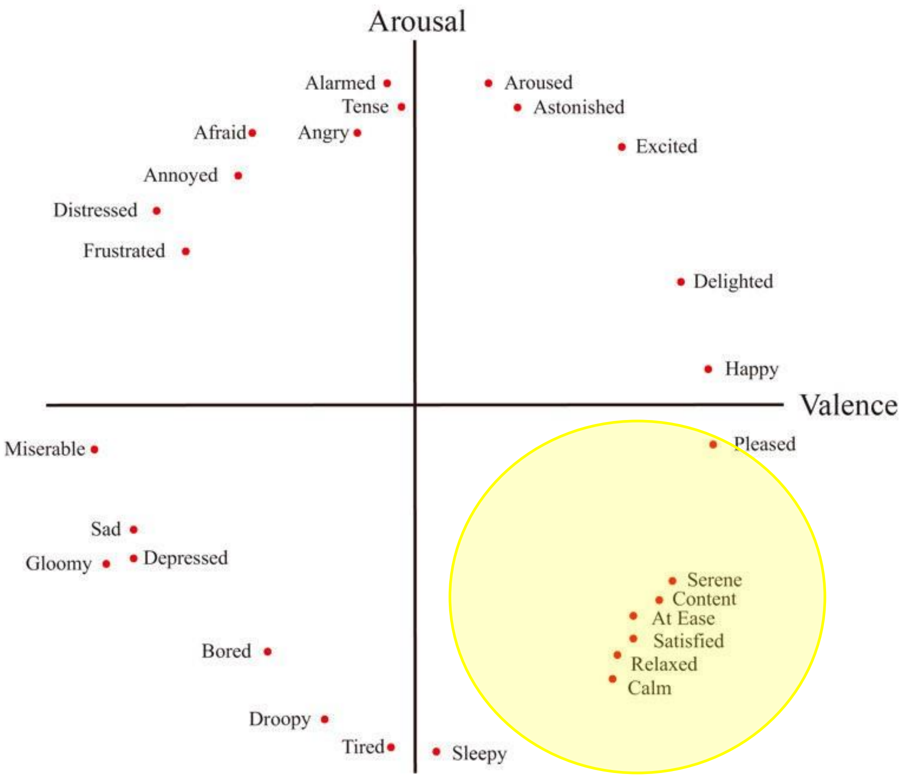


Figure 29 The Quadrant Containing Calm

With a better idea of the different emotions, I was trying to achieve, I could then reference the table of mechanics in **Appendix B**. I have taken an excerpt from this table with multiple examples including calm, or relevant emotions. These can be seen in **Figure 30**.

From referencing **Appendix B**, I was able to find different sets of mechanics and examples from existing games with the different potential emotions triggered to get an idea of what kind of emotions there are for that mechanic, and in what quadrant/s they would fall under. I liked the Two-Handed Interaction mechanic because the games that use the very hand-heavy interactions seem to bring excitement, interest, calm, and joy, which would keep my player in the first and fourth quadrants – a good goal for this prototype.

Interactions – Two Hands/Involvement: Mechanics that require the use of both hands offer immersive and engaging interactions. Developers should design these mechanics to feel natural and intuitive, enhancing player involvement and making the most of VR's unique capabilities.		
Game	Example Mechanics and Interactions	Emotions Elicited (Trigger Points)
BattleGroupVR	Navigating a 3D holographic map using hand gestures to control and command ships in a virtual space. Utilizing physical hand movements for ship interactions and map navigation.	Interest (Holographic interaction), Excitement (Control over ships), Joy (controlling 3D space)
Ragnarock	Drumming gestures involving both hands to enhance in-game elements.	Excitement (timing and coordination), Joy (combos), Engagement (Active physical interaction), Calm (repetition)
Job Simulator: The Slushie Machine	Using both hands to operate a virtual slushie machine, simulating real-world movements to dispense and create virtual slushies. Immersive and interactive two-handed simulation of a slushie-making process.	Joy (Interactive simulation), Interest (Realistic movement), Amusement (Creating virtual slushies)

Figure 30: Excerpts from Appendix B that contain positive emotions

Additionally, during the playtesting of various VR games, a significant pattern emerged in the interactions involving basic mechanics inspired by realistic environments, particularly within physics-based systems. These interactions not only evoked a sense of calmness but also initially sparked excitement and heightened arousal when players discovered these mechanics. I like to refer to this trend back to the established design principal of "Form follows function," where objects and interactions behave in a way that aligns with user expectations, mimicking reality. It's worth noting that this concept is not a novel concept in game design or user experiences. One such occurrence in games research comes from Celia Hodent (2020), in which one of the heuristics applied to her Games UX framework involves form follows function, drawing from existing games such as *Fortnite* (Epic Games, 2017). However, I noticed a scarcity of its application specifically to VR.

Hence, in this prototype, I made a deliberate choice to adhere to this guideline for several mechanics. From the realistic and whacky physics systems in VR games, the consideration for the physics and what was available as affordances to the player always relied on the environment. Therefore, I opted to create the game within a bedroom setting, aiming to establish a cozy and familiar environment. While the bedroom would contain essential furniture, each item would be initially packed within boxes, providing the player with the freedom to unpack and personalize their space. This context drew inspiration from the game *Unpacking* (Humble Games, 2021), which offers a serene experience centred around unpacking boxes and arranging items in new homes, featuring minimal puzzles and opportunities for home decoration.

Referring to **Appendix B**, I adopted three fundamental mechanics that guided my approach. Firstly, I embraced an extensive interaction system, which places a strong emphasis on engaging with every object within the environment. This choice reflects my intention to prioritize interactions, allowing players to engage with various elements throughout the game world and encourage calming exploration through the environment. Additionally, I integrated a realistic physics system with these interactions, designed to enhance realism and also provide an encouragement of positive motions through the "fun" aspect of the physics-based interactions. This realism not only adds to the immersive experience but also fosters a sense of comfort for players by aligning with their expectations of how objects should behave.

Furthermore, I intentionally incorporated two-handed interactions into the gameplay. This decision was driven by the desire to evoke heightened excitement upon discovery, fuelled by curiosity and the sheer enjoyment of employing both hands to interact with the game. These mechanics were carefully selected to create a captivating and engaging player experience.

With these three overarching mechanics in place, I proceeded to pinpoint a suitable theme for my prototype to align with each of these mechanics. This approach provided me with a structure to determine the specific mechanics that would adhere to my guiding principles. I categorized these mechanics into three primary domains:

- **Cleaning/Organising:** Emphasizing Two-Handed Interactions
- **Everyday Objects:** Incorporating Physics
- **Self-Care:** Fostering Interactivity

Cleaning/Organising

The first set of mechanics in Prototype One focuses on simulating the tasks of cleaning and organising a room. Taking inspiration from games like *Unpacking* (2021) and *Job Simulator* (2016), this mechanic creates a calming atmosphere by allowing players to engage in routine activities that promote a sense of order and cleanliness. This is backed up by observations I made during the Pilot Study – the first task for players in the Store Clerk game level required players to clean their space. There was no trash can in the immediate vicinity but was one in the distance players could throw objects into. While some players were happy throwing the trash in random directions and not particularly keeping their store clerk space clean, a sizeable chunk of participants were observed to be looking around for a trash can to throw the objects away in not just at the start of the game, but throughout. Follow up interview questions regarding their actions all confirmed they wanted to keep their clerk space clean and wished there was a trash can closer.

In addition to this task, another task from the pilot study that had some interest with the reactions was the option to decorate the store front display for the energy drinks. The creativity to explore different decorative set-ups and watch as it is then placed on visual display invoked excitement and curiosity in many players.

With this in mind, I intended to create at least two interactions focused on cleaning and organising.

Everyday Objects

The second mechanic in Prototype 1 focuses on interacting with everyday objects within the virtual room. This mechanic adds depth and immersion to the experience by allowing players to pick up objects, examine them closely, and place them in their appropriate locations. The tactile feedback and the ability to manipulate virtual objects contribute to the sense of presence and engagement, further enhancing the calm atmosphere of the prototype. While quite simple, even the most mundane interactions in VR can become extraordinary simply because it's not normal in games. Only VR can turn the interaction of turning a radio dial into the physical action of turning it like reality, whereas on mediums such as PC or console, that would involve pressing or holding a button.

Therefore, players can explore the virtual room and interact with various objects, such as books, decorations, or personal belongings. By designing interactions that mimic real-world actions and responses, designers can create a more immersive and believable environment. Additionally, by creating some differences in the mechanics of these simple objects, I can also further explore smaller minute differences in these mechanics for the future.

Taking Breaks and Self-Care

The third mechanic in Prototype 1 focuses on incorporating breaks and self-care activities within the virtual experience. These mechanics acknowledges the importance of well-being and provides moments of relaxation and rejuvenation for the player. This idea was not chosen to be as prominent as the other two areas but was chosen to explore further on the calming effects of certain mechanics in VR to help with mental health and relaxation. By promoting mechanics that involve taking care of yourself, "self" being the player character, but in VR the connection between the player character and player is physical. Therefore, I wanted to further explore realistic mechanics with the goals towards self-care and relaxation, determining if the effects are stronger towards calming emotions, then normal interactions.

5.4.1.1 Individual Mechanics

In Prototype One, which focuses on eliciting a calm emotion, a range of mechanics was carefully designed to create a serene and tranquil experience. These individual mechanics have been identified below and further explained with their purpose and intentions, as well as drawing direct inspiration from similar mechanics in existing VR games.

1. **Broom/Sweeping**: Players are provided with a virtual broom to simulate sweeping the floor. The rhythmic and repetitive motions of sweeping bring a sense of calmness and mindfulness as players focus on the task at hand. This mechanic is reminiscent of similar cleaning mechanics found in VR games like *Job Simulator* (2016), where players engage in simple yet satisfying cleaning activities and had positive results from the Pilot Study. This interaction is supported with two hands, with the goal being to create a more engaging interaction than the basics of picking objects up, pressing a button, etc. that promotes both calming emotions through the repetitive movement of sweeping, but also excitement through the more complex interaction.
2. **Puzzle Blocks:** The puzzle blocks allows players to arrange blocks into a puzzle box based on the shape of a block. Engaging with these puzzles promotes a calm and focused state of mind as players concentrate on finding solutions and achieving a sense of accomplishment. The puzzle blocks are optional and allow the player to explore if they decide to. The two-handed nature of this mechanic allow for an exciting break from the tasks, promoting the player to interact with this puzzle and calm down through the repeated actions and simplicity.

3. **Physics-Based Interactions with *all* items:** The objective of Prototype One is to arrange items in their designated places, creating a tidy and organised environment. This mechanic allows players to experience a sense of calm and satisfaction as they transform a cluttered space into an orderly one. Games like *The Room VR: A Dark Matter* (Fireproof Games, 2020) utilize similar mechanics where players must organise objects within a virtual room to uncover hidden secrets and progress through the game (however the environment sets the tone of *The Room VR*[2020] as tense). As seen in **Appendix B**, enjoyment and anticipation can be elicited in the right environment with this system, keeping the prototype from becoming to boring while still encouraging positive emotions to be experienced.
4. **Throwing Trash Away in Bin:** Players can engage in the act of throwing virtual trash into a bin, promoting a sense of cleanliness and order. This simple yet satisfying mechanic encourages players to maintain a tidy environment and appreciate the small acts of organisation. This task is primarily used to showcase to players the physics behind the interactions – encouraging them to explore with other objects to experience the different physics properties how each object react to being throw, hit, etc. The goal was to elicit excitement through this initial discovery of the physics, and maintain this through exploration with other physics-based interactions – the repetition will lower this excitement after the initial discovery wears off, but will hopefully maintain the positive state and instead transfer the player to a calm emotional state.
5. **Grabbing a Cup of Water:** Players are prompted to take a virtual break and engage in the self-care activity of hydration through grabbing a cup of water from a virtual dispenser. This refreshing activity offers a change of pace and allows players to momentarily disconnect from the virtual tasks, promoting a sense of balance and mindfulness. This unexpected interaction offers curiosity when prompted with the task, and satisfaction and excitement through carrying it out.

Because of the complexity of physics-based interactions, only one “official” mechanic was associated with it, but it underlies every interaction.

By incorporating these different mechanics into Prototype One, the aim is to create an immersive VR experience that elicits a calm and serene emotion. Each mechanic, whether it involves cleaning and organising, interacting with everyday objects, or engaging in self-care activities, contributes to the overall atmosphere of tranquillity and mindfulness.

5.4.1.1.1 Considerations for Other Mechanics

During the design phase, Prototype One initially encompassed a larger scale with a broader range of mechanics under consideration. However, as development progressed and considering the actual playtime observed during studies, the scope was narrowed down to a more focused selection. Here are some of the mechanics that were initially designed for Prototype One but were ultimately not implemented.

1. **Cardboard Boxes and Packaging Peanuts**: Interacting with cardboard boxes and packaging peanuts offers a calming sensory experience. Players can fold and stack cardboard boxes or throw around the packaging peanuts, providing tactile satisfaction and relaxation.
2. **Reading a Book:** Engaging with a virtual book offers a tranquil and introspective experience. Players can immerse themselves in a virtual narrative, enjoying moments of relaxation and escapism.
3. **Scribbling on a Notebook:** The act of scribbling on a virtual notebook provides a creative outlet for self-expression and relaxation. Players can freely draw, write, or doodle, fostering a sense of calmness and personal exploration. Similar creative tools can be found in VR applications like *Tilt Brush* (Google, 2016) where users can create art in a serene virtual environment.
4. **Chess:** Engaging in a virtual chess game offers a strategic and contemplative experience. Players can enjoy the mental stimulation and peaceful atmosphere of a game of chess, taking their time to plan their moves and appreciate the beauty of the virtual chessboard. This mechanic is reminiscent of chess mechanics found in VR games like *Chess Ultra* (Ripstone, 2017), where players can engage in peaceful matches against virtual opponents.
5. **Open and Close Blinds:** Players can interact with virtual blinds, opening and closing them to control the amount of light entering the virtual room. This mechanic allows players to create a serene and personalized atmosphere, similar to the environmental interactions found in games like *VR Home* (Dandover, 2020), where players can adjust lighting to suit their preferences.
6. **Thermos:** Players can engage with a thermos that features a removable lid. The act of removing and replacing the lid in a gentle and deliberate manner provides a tranquil and satisfying experience. This mechanic encourages players to appreciate the small

moments of mindfulness and sensory engagement, like interactions found in games like *Job Simulator* (2016).

7. **Watering Plants:** A particle system where players can water virtual plants, witnessing their growth and nurturing the virtual environment. This mechanic provides a sense of serenity and responsibility as players engage in nurturing activities.
8. **Cup of Coffee or Tea:** Engaging in the simple act of sipping a virtual cup of coffee or tea offers a moment of relaxation and comfort. This mechanic allows players to indulge in a sensory experience and enjoy a virtual break.

5.4.1.2 Order of Mechanics

I programmed the mechanics to all work individually, despite the tasks given to the player. If a player completed a task ahead of time, the task would auto trigger as complete and move on. The game prototype would consist of multiple tasks that require the player to interact with various mechanics to encourage interacting with all that the game level offers but allows freedom for interacting with all objects at any point. The tasks would be given via both audio prompts, as well as visually on a chalk board above the desk in the room. The written tasks on the chalk board were also accompanied by icons to give visual cues on what was required to complete the task.

The progression of mechanics were chosen logically based on a natural flow to get accustomed to the environment and controls. The task order is: 1. Empty a few items from the box (removing from box will trigger)

2. Clean up the dust on the carpet (use broom to sweep)
3. Clean up space by throwing away packaging mess (throw packaging peanuts x2 into trashcan)
4. Take a break, grab a cup of water (cup found in cardboard box, must pull on tap under water cannister to pour out water – cup must be under water dispenser to fill up – starting to drink, i.e. holding up to face, will trigger next task)
5. Customize desk by unpacking some office supplies (unpack three items on desk – in drawers, on top, any format acceptable)
6. Get more stuff to unpack by pressing the doorbell and getting delivery to come pick them up (pressing doorbell will remove the current boxes from the game level and spawn in new boxes with new objects to explore)

5.4.2 Prototype Two Mechanics Design

Since this prototype is focused on tense emotions, I will first begin with emotions that fall in the same quadrant on the Circumplex Model of Affect, which can be seen circled in **Figure 31**. Because it falls so close to the y-axis, I have allowed for some small overlap with the quadrant on the right, since the emotions at the beginning of that quadrant can still share similarities with tension.

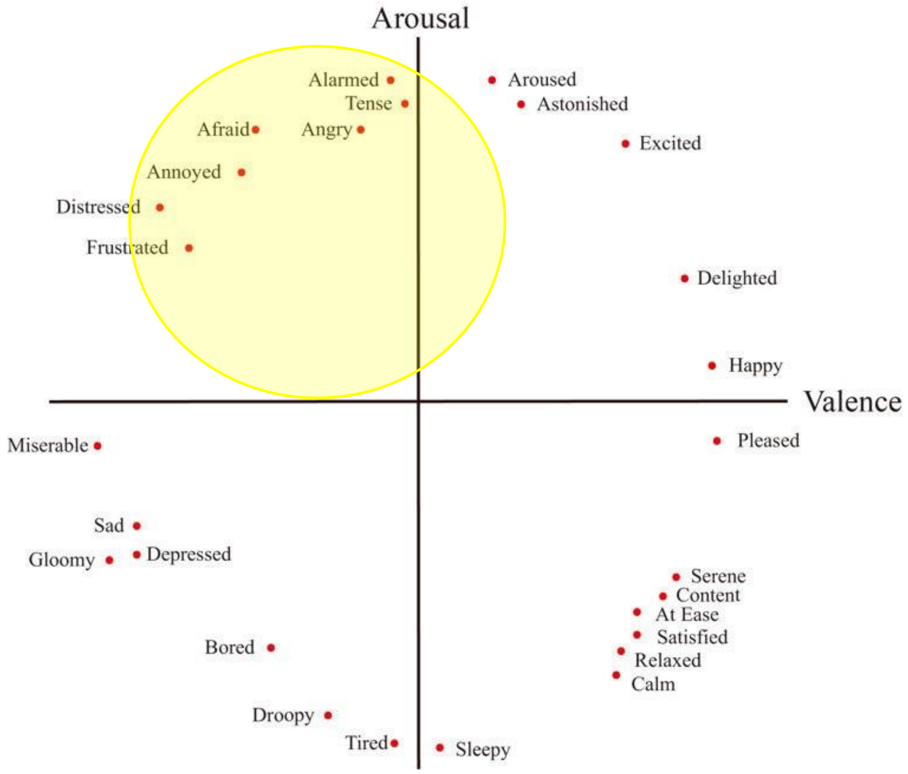


Figure 31 The Quadrant Containing Tense

With a better idea of the different emotions, I am trying to achieve, I can now reference the table of mechanics in **Appendix B**. I have taken an excerpt from this table with multiple examples including calm, or relevant emotions. These can be seen in **Figure 32**.

Physics – Realistic		
Implementing realistic physics in VR games can greatly enhance immersion and player engagement. By replicating real-world behaviours, such as weight, collisions, and object interactions, players feel more connected to the virtual environment. Developers should focus on maintaining consistency in physics interactions to ensure a seamless experience.		
Game	Example Mechanics and Interactions	Potential Emotions Elicited
In Death: Unchained	Archery mechanics requiring precision and aiming. Shooting with realism and accuracy in a bow and arrow VR game.	Anticipation (archery aiming), Tension (precise aiming)
The Elder Scrolls V: Skyrim VR	Realistic bow mechanics involving notch, draw, and vibrate when firing.- Detailed aiming system.	Anticipation (notching arrow), Excitement (shooting action)
Blade and Sorcery	Detailed weapon handling and physics-based combat. Realistic sword and weapon mechanics.	Aggression (weapon strikes), Excitement (satisfying hits)

Figure 32 Realistic Physics Excerpt

Exemplified in **Figure 32**, other than VR horror games which primarily rely on adjustments to the environmental design to cause constant tension through the unknown and sounds, many VR games with tension come from the action genre through a realistic physics system. These games create tension through several different combat mechanics. The first is realistic weaponry, which often involves reloading gun clips by either drawing the gun to the ammo clips on the player's waist, or having the player manually grab an ammo belt from their waist and loading it into the gun. Alongside reloading mechanics, there also exists the physical aiming of the gun, and the firing of the gun. On VR controllers, there is often a button on the back that is called trigger and mimics the trigger of a gun, which can be seen on the Quest Touch controllers in **Figure 33**. All these combines to create an immersive experience when shooting the guns. The tension comes from the use of guns in different scenarios – fighting zombies, reloading while trying to run away, etc.

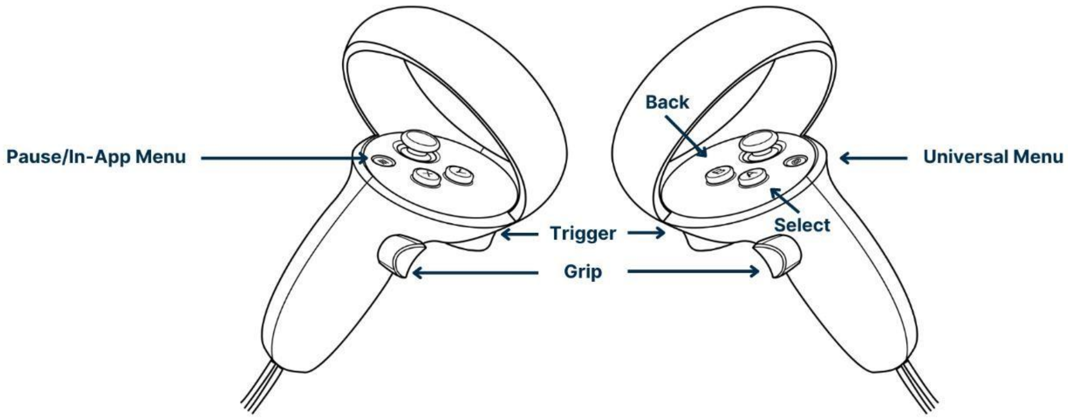


Figure 33 Example of VR Controller Design from the Quest Touch

Another similar scenario comes with melee interactions – using swords, shields, and other types of tools. Rather than pressing a button to swing a sword at the same angle every time, VR has the player holding the sword and swinging it however they want to. Not only this, but the movement itself – stepping forward to attack, or spinning around to do a fancy 360 sword slash, all becomes possible in VR.

Lastly, a mechanic that is often combined with either long range weapons or close-range weapons centres around a dodging mechanic. With all the possible movements of VR, players are often required to physically move around dodging – from bullets or opponents, crouching behind obstacles for cover, or physically moving to the side to avoid an opponent's downward sword slash. These mechanics are often coupled together, which create the tense environment that keeps players always on their toes.

In **Appendix B**, the realistic physics-based interactions seemed the most appropriate for maintaining states of tension. This is largely in part due to this mechanic being found in most action games, with weapons as the core interactions.

Prototype Two aims to mimic this constant state of tension by choosing a weapon-based mechanic – the bow – and inducing tense state through the hunting of different animals – all of which will respond differently, creating variations in the environment to keep the tense state maintained. There was no narrative goal to the prototype, just an aim to explore how a physics-based mechanic can not only introduce feelings of tension, but *maintain* this tension longer scale.

5.4.2.1 Individual Mechanics

Several mechanics have been implemented to create an immersive and suspenseful experience for the player. Drawing inspiration from existing VR games, we can explore how each mechanic contributes to the overall sense of tension and excitement.

1. **Bow:** The bow serves as a core mechanic in Prototype Two requiring players to physically draw the bowstring, aim, and release arrows at their targets. This mechanic adds a layer of skill-based gameplay and intensifies the tension by requiring precise aiming and timing. Similar to games like *In Death* (Sólfar Studios, 2018), *Holopoint* (Alzan Studios, 2016), and *Apex Construct* (Fast Travel Games, 2018), where bow mechanics are used to engage enemies, the bow in Prototype Two creates a heightened sense of anticipation and challenge, as players must rely on their accuracy to overcome obstacles.
2. **Practice Range:** The inclusion of a practice range provides players with an opportunity to familiarize themselves with the bow mechanics and hone their skills. This mechanic enhances the tension by setting the stage for the upcoming hunting tasks. Players can experience a sense of anticipation and readiness as they prepare themselves for the challenges that lie ahead. This concept can be compared to games like *The Lab* (2016) and its "Longbow" mini-game, where players have the chance to practice their archery skills before facing more challenging scenarios.
3. **Hunt:** The hunting mechanic introduces various animals with distinct behaviours, each contributing to the tension and suspense in different ways:
    a. Deer: When the player comes near the deer, the deer start to eat, only running away if the player gets too close. This mechanic increases tension as players must approach the deer stealthily and time their shots accurately. Similar mechanics can be found in games like *The Hunter: Call of the Wild* (Expansive Worlds, 2017), where players must consider factors such as scent, sound, and visibility to successfully hunt deer.
    b. Bunny: Smaller and more skittish, the bunny exhibits similar alert and evasion behaviours to the deer. Its smaller size and quick movements pose a challenge to players, requiring precise aim and timing to hit their target. Games like *Arizona Sunshine* (Vertigo Games, 2016) feature similar mechanics, where players must aim carefully to shoot fast-moving targets, creating heightened tension through the increased difficulty.

c. Wolf: The wolf introduces a new level of tension with its alertness and aggression. It will begin to howl when it senses the player get close and will actively attack the player if it can see you and you are near, demanding quick reflexes and accurate shots from players.
d. Bear: The bear serves as a formidable opponent, with increased health and a penchant for aggression. It does not have an alert state and will go directly to attacking if it can see the player. Its attacks are more powerful, and players must employ careful strategy, precise aiming, and swift reactions to survive. The presence of a bear creates a heightened sense of danger and tension.

Additionally, the hunting mechanic was accompanied by animations for each of the animals. The inclusion of various animations for each, including idle, walk, run, attack, hurt, and death, adds realism and enhances the tension of the hunting scenarios. These animations make the animals feel more lifelike and create a sense of urgency and intensity during encounters. Games such as *Arizona Sunshine* (2016) demonstrate similar mechanics, where zombies exhibit different animations based on their states, heightening the sense of danger and tension.

By incorporating all these mechanics into Prototype Two, the goal is to immerse players in a tense and thrilling VR experience. The bow and mastery it involves, the tension of starting at a practice range becoming more proficient, and the increasing difficulty found in hunting tasks with various animal behaviours collectively contribute to the heightened sense of tension, challenge, and excitement throughout the gameplay.

5.4.2.1.2 Why a Bow?

With the bow being the core of this prototype, I felt it was important to further explain the choice for this mechanic. A bow is one of the most notable and prominent mechanics that can be found in VR games, dating back to initial games created for VR to showcase its potential in game experiences.

One earlier example of a bow mechanic can be found in *The Lab* by Valve, from 2016. In this VR game, players engage in a variety of mini-games and experiences set in a whimsical virtual world. One of the mini-games features a bow and arrow gameplay segment known as "Longbow."

In "Longbow," players are positioned on a castle rampart, defending against waves of approaching enemies. As enemies advance towards the player, they must use the bow to accurately shoot arrows and eliminate the oncoming threats. The tension arises from the combination of precision aiming, time pressure, and the increasing difficulty of the enemy waves.

The mechanics of drawing the bowstring, aiming at distant targets, and releasing the arrow create a sense of focus and anticipation. The physicality of pulling back the virtual bowstring and the subsequent release of the arrow triggers a feeling of empowerment and intensity. The visual and audio feedback, such as the satisfying "thwack" sound upon hitting a target or the enemies' menacing approaches, heightens the sense of tension and urgency. Tension arises at multiple stages, from getting accustomed to the bow at the beginning, to shooting fast enough when defending from more targets later.

Another example of tension-inducing bow mechanics can be seen in *Apex Construct* (2018) by Fast Travel Games. In this VR action-adventure game, players wield a high-tech bow and navigate a post-apocalyptic world. As players encounter hostile robotic creatures, they must utilize the bow to defend themselves and progress through the game.

The mechanics of the bow in *Apex Construct* (2018) involve physically drawing back the virtual bowstring, aiming at enemies, and strategically releasing arrows to defeat them. The tension arises from the combination of precise aiming, limited resources, and the relentless pursuit of the robotic adversaries. Players must carefully consider their shots, time their attacks, and swiftly react to the enemies' movements to survive.

These instances taken from *The Lab* (2016) and *Apex Construct* (2018) vividly demonstrate how the mechanics of using a bow in VR can evoke feelings of tension and excitement. The physical act of drawing and releasing the bowstring, coupled with the requirement for precise aim and quick reflexes, generates a heightened sense of engagement and presents a notable challenge. It's worth highlighting that bow mechanics can be encountered in various games, not only as the primary mechanic but also as a secondary one. In numerous action games that offer a range of weapons, it is common to find a bow (or another projectile-based weapon, sometimes a gun, depending on the genre). By drawing inspiration from these mechanics and incorporating them into Prototype 2, the aim is to provide players with similarly exhilarating experiences that elicit the desired emotion of tension.

5.4.2.2 Order of Mechanics

The order of mechanics in this prototype were directly designed to consider the mastery of using a bow in VR. Encounters with different animals were created with progressing difficulty, whilst also keeping the reactions of the animals distinct and different to create the uncertainty and tension maintained with the player.

However, before being able to dive into hunting with a bow, I identified the need to get accustomed with how to use the bow and aim, load, and release. To address this, I created the first task, which required the player to get used to using the bow by shooting at least three arrows that hit a shooting target. I did not designate the distance to be standing from the target, adding some leeway for the task – which would later prove to be valuable to the player.

An additional thing to note with this prototype – there is no goal of creating a narrative or exploring aesthetics such as adjusting the appearance and ambience of the forest environment. While there are different animals you are supposed to be hunting, and if you "die" there is dialogue stating park rangers saved you, the focus is to create a prototype where the experience is centred on experiencing the mechanics and exploring the mechanics.

5.5 Summary

This chapter delved into the design and development of two VR prototypes as a practical application of this thesis' framework for designing VR mechanics that elicit targeted emotions. The initial design of the prototypes was guided by the choice of measures to be evaluated during playtesting. The two chosen emotions for exploration were calm and tense, which were seen as contrasting emotions with potential significance in immersive experiences and were influenced from the initial research of this thesis.

Prototype One focused on physics-based interactions within a closed environment. The measures evaluated in this prototype encompassed an evaluation of a closed environment, a comparison of the individual physics-based interactions, impact of visual signifiers. The development process involved creating a bedroom setting with interactable objects and implementing realistic physics behaviours. The prototype aimed to provide insights into designing VR mechanics that calm emotions within a small space with a fully interactable environment, each object with their own behaviour.

Prototype Two centred around bow mechanics and mastery in an open space environment. The measures evaluated in this prototype included the emotional impact of different locomotions, response towards one primary interaction mode (tool versus hands) via a bow, mastery of using the bow and skill development, alongside an open environment with auditory-only signifiers. The development process involved designing an expansive environment, implementing realistic bow mechanics, and programming animals with AI and animations to react to the player with different behaviours, progressively challenged the player's skills. Prototype Two aimed to shed light on designing VR mechanics that evoke tense emotions within an open environment, focusing on bow mechanics, mastery, and varying locomotion.

The selection of mechanics followed the design process of my framework outlined in the previous chapter. With the emotions having been chosen, I took excerpts from the mechanics table in **Appendix B** that corresponded to both calm and tense. With the broad guidelines of these mechanics, taken from existing VR games, I was able to come up with several example mechanics for each prototype. While the prototypes scales were initially much larger, the scale was shrunken down to fit both a realistic time for playtesting, as well as to fit within an appropriate development time frame.

Throughout the development process of both prototypes, iterative testing and refinement played a crucial role in optimizing the emotional impact and user experience. I carried out constant playtesting and observations to identify areas for improvement and to fine-tune the mechanics, environments, and overall emotional journey.

By providing detailed walkthroughs of each prototype's development, this chapter provided a comprehensive understanding of the design choices, implementation strategies, and iterative processes involved in creating immersive VR experiences that elicit targeted emotions. The prototypes serve as valuable contributions to the exploration of designing VR mechanics that effectively evoke emotions, specifically focusing on calm and tense experiences.

Overall, this chapter showcases the potential of this thesis' framework as a tool for designing VR mechanics that elicit targeted emotions and lays the foundation for the subsequent chapters that will analyse the findings, discuss the implications, and provide recommendations for future research and design in the field of VR emotion elicitation.

Chapter 6: Pilot Study Results & Discussion

6.1 Introduction

Given that the pilot study primarily relied on interviews as the main data collection method, Chapter 6 presents a limited amount of data to demonstrate the results. Consequently, before attempting to identify the outcomes of the pilot study data, I will first discuss the trends and outliers observed in the interviews.

To better understand the results of the pilot study, I will first breakdown what the Store Clerk level of *Job Simulator* involves and introduce the varying mechanics participants will encounter. The Store Clerk level immerses players in the responsibilities of serving customers at Slush-E Mart. This involves providing or preparing different foods, scratching lottery tickets, creating jumbo slushies, and more.

The first collection of these mechanics centres around the utilities provided to the player. The environment is all room-scale, with the player only needing minimal physical movement to reach any shelf or storage. The utilities can be understood in **Figure 34**.

Utilities	Description
Hot Dog Grill	Melts sausages, can cause burning if overcooked. Add buns, ketchup, and mustard.
Slush-E machine	Fills paper cups with slushies. Day flavours: Battery Acid Blue, Thermal Paste Pink. Infinite Overtime flavours: Short Circuit Green, Sleep Mode Purple. Levers pour drinks. Can mix drinks.
Display Case	Showcase for products. Items defy gravity, stay in place. Can transport to a table. No impact on customer traffic.
Jumbo Sizer	Expands placed items. One-time expansion. Button activates. Multiple items expand, might displace others.
Scanner	Scans items for customer charges. Scan raises price, even for same item.
Sale-O-Matic	Cash register with lever, buttons, displays, drawer. Modify prices: Job Bot Bargain (50% off), 5 finger discount (Free), Buffer overflow (Price doubled), Bot Vegas Special (Random price). Displays show costs.
Storage Units	Freezer (hot dog sausages, Job bot pops, Popsicles, Burritos) Fridge (Max energy drinks, soda bottles) Snacks (Crisps, Candy bars) Safe (Cheese – BanditBot steals 3)

Figure 34 Utilities in Store Clerk Level of Job Simulator (2016)

Task	Description
Open for Business	Clean counter, turn on security cameras.
Breakfast of Champions	Customer buys chips & hot dog. Scan chips, grill sausage, put in bun.
Maximum Sugar Intake	Customer buys 2 chocolate bars & jumbo slushie. Make slushie with Slush-E machine.
Lucky Numbers	GrannyBot buys newspaper & lottery ticket. Scratch ticket. Reacts to outcome.
Are You Talking to Me?	Bot wants hot dog & gum. Prepare hot dog, get gum. Bot rushes.
Sugar Rush!	Mother & daughter buy banana. Daughter requests sweets. Give 3 items. Pay after mother returns.
Get Stackin'	Customer with "Energy" hat places items, goes to toilet, asks for "cleaning". Can throw any item.
Energize!	Bot wants Maximum Energy drink. Shake drink until red. Bot drinks & leaves.
Retail Therapy	Moustached bot wants 3+ items. Scan items, put in bag. Pull cash register lever. Pay with green & pink bills.
Special Delivery	Moustached bot with box wants items placed. Task ends after completion.
Spare a Byte to Eat	Customer wants free item. Give popsicle, then change. Customer asks again. Give any item.
Stick 'Em Up!	Bandit Bot demands cheddar from safe. Give cheddar. Police chase Bandit Bot. Can take banana from hand.
Burrito Troubles	Bot wanders, wake with object. Bot asks for burrito at cash register.

Figure 35 Tasks in Store Clerk Level of Job Simulator (2016)

While the utilities provide the player with exploratory options for mechanics, there is also a task system that directs certain interactions. The tasks, in order, can be found in **Figure 35**. I have also embedded a video for reference of the basic gameplay (Delco, 2016) – with 15 to 20 minutes of playtime during each session with participants, this video accurately depicts the experience participants went through. However, not every participant followed the linear task progression provided – many also explored on their own – and the speed at which participants carried out their tasks all varied. Therefore, the ending point and ending task of each participant was different. Some only made it to *Get Stackin'*, while others made it all the way to *Burrito Troubles*.

Media: Playthrough of *Job Simulator* (2016) from Delco (*Job Simulator – Store Clerk [No Commentary]*, 2016)

6.2 Methods

The pilot study comprises an initial survey, observations, and recordings conducted during play, followed by an interview at the conclusion. The specifics of each method and their respective outcomes are outlined in the subsequent subsections, followed by a breakdown of the results in **6.3**, and a discussion in **6.4**. The qualitative analysis methods involved identifying themes and commonalities in the data to understand emotional responses. In the Pilot Study, this was primarily through data from the semi-structured interviews, where most of the data was gathered.

6.2.1 Session Schedules

Each session commenced with necessary paperwork, including the Consent Form, Participant Information Sheet, Beck Anxiety Inventory, and Questionnaire. Time was allocated between sessions for cleaning and adhering to COVID safety protocols. Additionally, optional breaks were provided during each session to accommodate participants experiencing motion sickness or dizziness. Participants were also informed of their right to withdraw or halt the session at any point.

During the Pilot Study, sessions typically lasted approximately one to two hours, with 15 minutes dedicated to paperwork, 5/10 minutes for setup (depending on adjustments to VR headset and ensuring player is completely comfortable), 20 minutes for gameplay, and a final 15 minutes allocated for the interview. The unaccounted-for time can also include pauses during play, longer time spent on paperwork and setup, and longer interviews. On average, I conducted sessions with five participants per day. Flexibility was required at the outset due to technical challenges with VR connectivity, variations in play environments, and other unforeseen circumstances.

6.2.2 Questionnaire

The questionnaire initially collected basic information from participants regarding their level of familiarity with VR, rated on a five-point Likert scale ranging from 1 (‘not familiar at all with VR games’) to 5 (‘plays VR games weekly’). Participants were then asked to complete the HEXAD Questionnaire.

The HEXAD Questionnaire consists of a series of statements presented on a seven-point Likert scale. The statements and their associated player types were taken from HEXAD, but randomized for participants (Tondello et al., 2016). These statements can be seen below in **Figure 36**.

Statement	1 *"Strongly Disagree"*	2	3	4	5	6	7 *"Strongly Agree"*
It makes me happy if I am able to help others.							
I like mastering difficult tasks.							
Return of investment is important to me.							
I enjoy group activities.							
I like helping others to orient themselves in new situations.							
If the reward is sufficient, I will put in the effort.							
I like sharing my knowledge.							
I see myself as a rebel.							
Rewards are a great way to motivate me.							
I like defeating obstacles.							
Opportunities for self-expression are important to me.							
I dislike following rules.							
Interacting with others is important to me.							
I often let my curiosity guide me.							
I like being part of a team.							
The wellbeing of others is important to me.							
It is important to me to follow my own path.							
I enjoy emerging victorious out of difficult circumstances.							
I like to provoke.							
Being independent is important to me.							
I like to question the status quo.							
It is important to me to feel like I am part of a community.							
It is important to me to continuously improve my skills.							
I like competitions where a prize can be won.							

Figure 36 Hexad Questionnaire

6.2.3 Interview Questions

The interview questions for the Pilot Study were focused on understanding the individual emotions participants felt, as well as the overarching emotional journey and different affective states they went through during play. Further questions were included to understand the impact of play space in VR, the number of affordances, and signifiers/feedback in VR. The questions used were intended to be open-ended and facilitate further discussion, without guiding participants to any sort of desired response. The questions can be seen in **Figure 37**.

Understanding emotional impact and journey
What overall emotion did the game make you feel? Can you rate the intensity of this emotion on a scale of 1 to 5, with 5 being the most intense?
Can you take me on the journey of emotions you felt from the start, during, and at the end of the playthrough?
Was there any moment that strongly stood out to you emotionally, either positively or negatively? How did you react?
If mentioned only positive or only negative to previous question, ask if there as an inverse of it. Ex: if negative given, ask if there was anything that elicited a very strong positive response
Understanding the role of many individualized mechanics in a room-scale space, and how the feedback format performed
Did you find following the tasks frustrating or limiting?
Did the amount of affordances available overwhelm you at any point? If so, would you identify it as a negative impact?
Understanding player expectations
Were the instructions ever unclear on how to proceed or to carry out an action?
Did any of the interactions with customers or actions with your environment result with unexpected outcomes? How did it make you feel?

Figure 37 Pilot Study Interview Questions

6.2.4 Observations

Observations were conducted during gameplay. To minimize the potential influence of observation on the participant, I voluntarily positioned myself outside the play area, maintaining a distance to create a barrier between myself and the participant. I sat behind a table near the entrance, allowing for discreet observation while avoiding direct involvement in the participants' experiences.

During the play session, I took notes on observations made and later cross-checked them with recordings of the session. This method allowed for thorough documentation and verification of the observed behaviors and interactions without interfering with the participants' experiences in real-time.

Observations were combined with the results from the interviews, as they primarily served to support the main data collected. This can be found in **6.3.1.**

6.3 Results

6.3.1 Interviews with Observations/Recordings

6.3.1.1 Themes

Following the interviews and responses from participants, I set to classify and sort responses to find commonalities between them using thematic analysis. I have identified these themes and will explore each of them and what they involve below. Quotes are provided afterwards to support the understanding of the emotional responses, as well as highlight the interactions that could have provoked these responses.

The pilot study involved participants playing the store clerk game level in *Job Simulator* (2016), and their responses provided useful insights into their experiences and perceptions. The following six themes emerged from the analysis of the pilot study data, seen in **Figure 38**.

Themes
Physicality in Interactions
Signifiers and Clarity of Objectives
Performative Behaviour and Social Interaction
Tool Designs
Playful Interactions
Exploratory vs. Task-Focused Behaviour

Figure 38 Themes from Pilot Study

1) **Physicality in Interactions:** Participants generally enjoyed the game's basic interactions, such as opening shelves and handling items, for their intuitive and physical nature. However, grip and opening mechanics led to frustration for some. Removing certain interactions and considering even the textures used for basic actions could enhance user experience. One participant experienced a phobia (touching metal), indicating the need for deeper consideration of every aspect in an interaction – including the visual appearance. Some frustrated participants identified specific instances that caused frustration – such as difficulty putting the money away into the cash register. Others found initial unfamiliarity with interactions frustrating, which subsided once understood.

2) **Signifiers and Clarity of Objectives:** Participants encountered issues understanding certain objectives, like handing items to the little girl customer. Lack of clarity caused inconvenience, and unclear imagery on instructions boards compounded this. Some attributed difficulties to physical space constraints, impacting their interaction reach. This issue also affected tasks involving accurate throwing, where misaligned hitboxes led to task failure, necessitating clearer task cues. The main task this occurred with was when the player was requested to throw something to the bathroom door across the room to clean up a spill. If the item did not land on the door, it would not trigger any progression. However, without knowing it needed to hit the specific place, many players felt they were proceeding incorrectly when the throwing failed to trigger too, leading to stagnation in gameplay and frustration as an emotional response.

3) **Performative Behaviour and Social Interaction:** Participants exhibited performative behaviour during gameplay, sometimes influenced by the presence of the researcher. VR's interactive nature triggered strong reactions, spanning joy, frustration, laughter, and playful interactions with virtual characters. Socially inclined players engaged in talkative behaviour, holding conversations with virtual customers, expressing emotions ranging from giggling to mild cussing, and directly responding to customer dialogues. Examples include a responding to the child customer demanding candy with "I ain't giving you anything", or telling a customer they "didn't say please". Another example – one task was to edit the visual display stand, the participant remarked "This display? Oh, this one!", when trying to find where it was. Another participant commented "Nice" when seeing the robber caught by police when leaving the store.

4) **Tool Designs**

   a. **Bin Annoyance:** The absence of a cleaning bin in the VR environment led to notable frustration among participants, underscoring a distinct preference for cleanliness and highlighting the necessity of designated cleaning zones. This divergence in player expectations vividly illustrated how player motivations and anticipations significantly influence emotional responses. One participant conveyed their evident annoyance when they glanced around at the beginning and found no accessible bin for tidying up their virtual space. It's worth noting that some participants even made an effort to toss objects into a bin, despite it requiring a more challenging throw and not being conveniently located within the immediate player area.

      The significance of the bin's inclusion in the VR environment is noteworthy due to the heightened nature of experiences in virtual reality. As demonstrated by games like Job Simulator, where everyday tasks are exaggerated and amplified, elements like the cleaning bin become even more crucial. The absence or presence of such elements can considerably impact players' immersion and emotional engagement, showcasing the pivotal role that subtle design choices play in shaping users' experiences in VR.

   b. **Slushie Machine Handling:** While predominantly using one hand for the slushie machine, participants who used both hands expressed surprise and enjoyment, citing it as a favourite interaction. Dual-hand interaction enhanced presence and realism, deepening the immersive experience.

c. **Jumbo Concept:** The Jumbo-sized cup concept intrigued participants, offering a fun element despite its exaggerated size. While reactions were generally positive, some participants had significantly more positive responses.

5) **Playful Interactions:** Several participants enjoyed engaging in playful interactions, such as using finger guns or flicking off annoying customers. These actions provided a sense of amusement and allowed participants to explore the freedom and possibilities within the virtual environment.

6) **Exploratory vs. Task-Focused Behaviour:** Participants exhibited diverse gameplay preferences. Some engaged in exploratory behaviour, experimenting with game mechanics beyond tasks and pushing the boundaries of the game mechanics. Some examples of these interactions include shaking the soda bottle and making it fly away, drinking the customer's slushie, selling customers' items back to them, and more. Others adhered strictly to tasks, focusing on cleanliness and precision, often exceeding task expectations. For example, a participant threw the rest of the hot dogs away that were not sold, remarking on their desire to keep the space clean. Other participants would unbox the new stock items nicely and even perform ahead of the tasks by putting the hot sauce back in its green tin, without any task guidance.

The pilot study's themes shed light on player interactions and preferences in the store clerk game level. To delve deeper into these results and extract actionable insights from the identified themes, we can analyse emotional responses and examine direct quotes. While observations supported the initial thematic analysis, direct quotes provide stronger evidence for understanding emotions.

6.3.1.2 Emotions

Given that the outcomes of the Pilot Study predominantly revolve around the transcriptions from the conducted interviews, the extent to which data was translated into tabular formats in Excel remains limited. Presented in **Figure 39** is a table that outlines the precise number of responses from participants who recognized individual emotions experienced during the gameplay session. The total number of participants was 17, with many indicating multiple emotions, thus contributing to a higher aggregate count of responses.

Quadrant	Emotion	Number of Responses
1	happy	4
	fun	9
	intrigued	4
	joy	5
	amused	1
	excited	1
4	calm	5
	curious	2
	entertained	4
	relaxed	2
2	puzzled	1

Figure 39 Emotions by Number of Responses in Pilot Study

For reference, the quadrants act as mathematical quadrant labelling, which can be seen in **Figure 40.** The quadrants labelled are applied to better understand where they fall on the Circumplex Model of Affect. While this model was not used until the main study, they are useful to classify the emotions into groups – with most of the terms being positive (positive valence in Quads 1 and 4, and a one more neutral response just at the edge of quadrant 2 (puzzled).

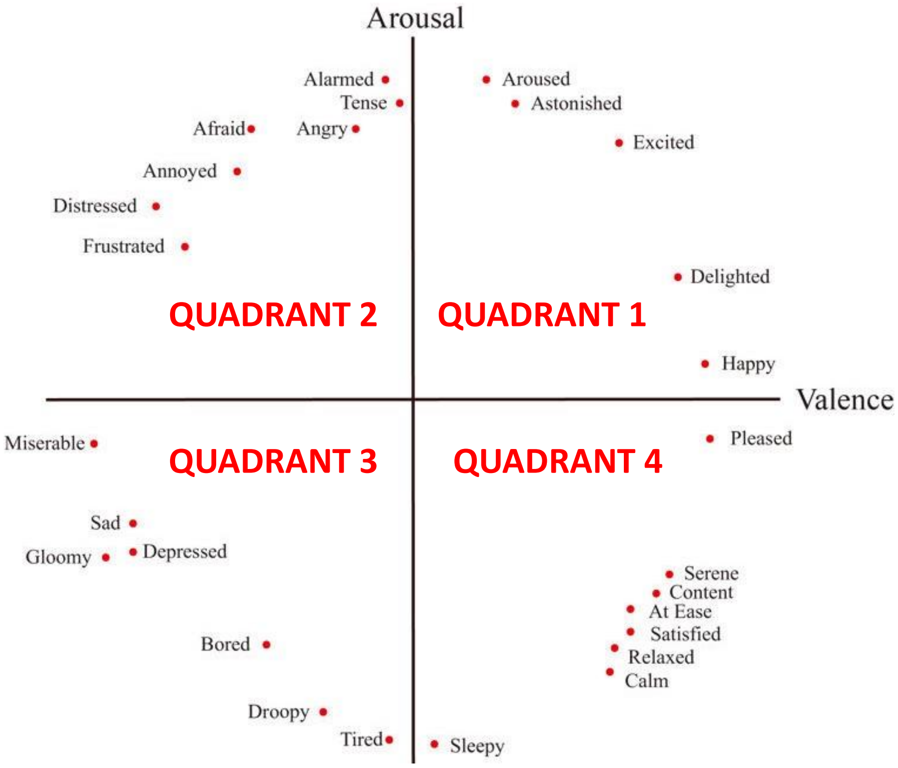


Figure 40 Quadrant References

These quads will be used as a thematic category to sort participants' quotes, with some observations mixed in as well.

The labelled quadrants are utilized to better comprehend their placement on the Circumplex Model of Affect. Although this model was not employed until the main study, it proves valuable in categorizing emotions into groups. Most terms lean towards positivity, with positive valence in Quadrants 1 and 4, and one slightly neutral response bordering Quadrant 2 (puzzled). It is important to note participants also mentioned instances of frustration, but never directly said this emotion as the main feeling during play – hence it missing from **Figure 39**.

These quadrants serve as thematic categories to organise participants' quotes, supplemented by some observations. These can be found in **Figure 41**.

Quadrant 1 – Excited/fun
Active participation included behaviours like: • finger guns • waving at customers • shook soda bottle and made it fly away • tried to open and read comic and exploring how the individual interactions work with each other: • selling customers items back to them (ex – sunglasses on customer's face) • using fireworks to shoot the robber • pulling both handles of slushie machine at once, mixing colours of both slushie options, jumbo sizing a cup for bigger slushie
Active participation via dialogue too: • others would express happiness when discovering something or achieving a task such as "yay", or giggling • participant replied to an NPC asking "What is this, your first job?" with "Yep" • participant expressed to themself in surprise when discovering tipping a drink to his mouth in VR made glug glug noises and drained the liquid – "Cool! It does glug glug." •
Quadrant 2 – Puzzled/Frustrated
Lack of a bin nearby to throw trash away: • Three participants burnt hot dogs and wanted to throw them away immediately. Two of them struggled to throw the items accurately into the only bin placed further away, one participant did not see the bin.
Game task that makes you give candy to a child while the mom is not watching: • "I shouldn't be doing this" • "I ain't giving you anything"
Annoying/Rude customer on the phone • "Can you agitate the customers?" -> frustration at not being able to

• "So rude", tried to rub a hot dog in the customer's face
Quadrant 4 – Calm/Relaxed/Entertained
These emotions involved the slower active participation than quadrant 1. Some examples include: • tossing coins between their hands • throwing items in the bin • melting popsicle on grill • using a coin on the lottery tickets to try and win • put glasses on their own avatar's face, then customers' faces • jumbo sized a plant and put it on display
Active participation via dialogue: • participant ate a customer's banana then said "Sorry" • participant burnt hot dog and told customer "It's burnt, sorry"

Figure 41 Quotes for Emotional Quadrants

Having outlined the primary insights from the Pilot Study regarding the various themes of the types of interactions and their emotional responses, substantiated by direct instances from gameplay, we can now transition to the questionnaire results. This will allow delving deeper into the additional data gathered before conducting a detailed analysis of these results.

6.3.2 Questionnaire

Due to the majority of data being collected via interviews in the Pilot Study, the data from the questionnaires will have minimum data tables to provide. The first and foremost information regards the participants' familiarity with VR, found in **Figure 42***,* with one being not familiar, and five being weekly.

VR Familiarity	Number of Participants
1	1
2	6
3	8
4	2
5	0

Figure 42 VR Familiarity in Pilot Study

The player types were gathered via the questionnaire using the HEXAD framework. The responses can be found in **Figure 43.**

HEXAD Player Type	Number of Participants
Achiever	6
Disruptor	1
Free Spirit	4
Philanthropist	4
Player	2

Figure 43 Player Types in Pilot Study

6.4 Discussion

Before addressing the results and analysing the trends, I would first like to present and discuss several factors that could potentially affect the results, the first and foremost of these being participants' familiarity with VR. This can be seen in **Figure 44**.

Additionally, to get a better understanding of the general emotional responses of participants to the *Job* Simulator (2016) play experience through the level "Store Clerk", I identified the key terms participants used during interviews. The findings from these interviews have been presented as a bar chart in **Figure 45.**

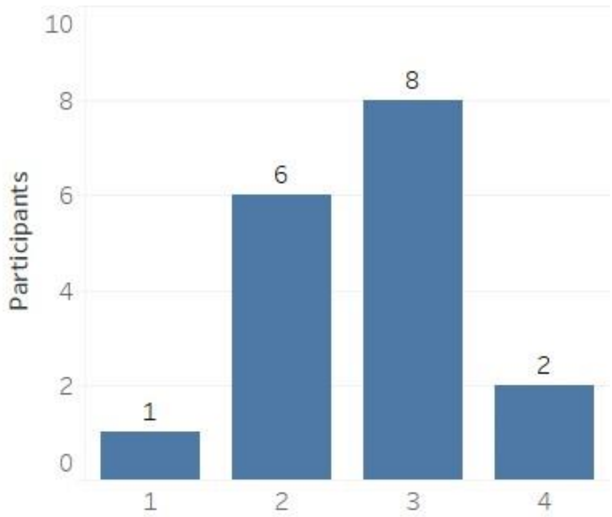


Figure 44 VR Familiarity of Pilot Study

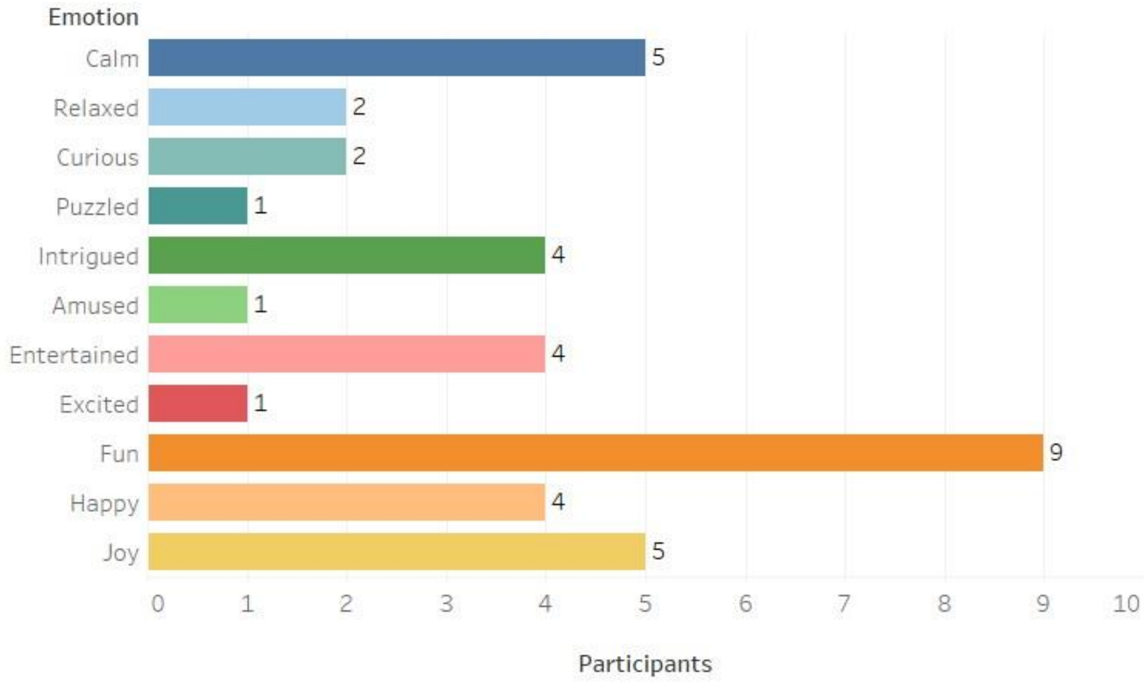


Figure 45 Emotional Responses of Participants in Pilot Study

While analysing the data, it was evident that the participants exhibited varying levels of familiarity with virtual reality. Although there was a significant dispersion of responses in the middle range, the majority of participants reported having very limited exposure to VR. The limited exposure to VR had an interesting impact on the participants' emotional responses. It was observed that some individuals experienced heightened arousal and excitement during the VR sessions. This could be attributed to the novelty and novelty-seeking behaviour associated with trying VR for the first time, which was expressed during the interviews as sentiments of wonder with VR itself from participants. This phenomenon potentially skewed the results, as these participants might have exhibited more intense emotions compared to those with more extensive VR experience.

However, should this prove to be a consistent result from players who are new to VR, there is still potential for a unified emotional experience. As VR becomes more accessible and widely used, we can anticipate a normalisation of emotional responses, aligning more closely with established patterns and expectations. Therefore, these findings need to be interpreted in the context of the current stage of VR adoption and acknowledge the potential influence of novelty effects on emotional experiences.

Additionally, some players with no VR experience were found to perform more efficiently and more comfortably in this pilot study than others who had identified previous VR experience.

Conversely, variables such as gender and age were not able to be extensively evaluated in the Pilot study. In the Pilot Study, there were four women. The age group of participants was also on the younger side, primarily between eighteen and twenty-five. It's worth noting, however, that these findings could potentially shift with an expanded participant pool or through exploration of further diverse mechanics and emotions. The main study would be focusing on further variation.

6.4.1 Emotional Responses

The pilot study shed light on the variations of emotional responses that the gameplay elicited. As participants navigated through various tasks, their emotions presented a dynamic progression that encompassed the initiation, progression, and culmination of their virtual experience. Additionally, several mechanics seemed to elicit heightened emotional responses from multiple participants, suggesting their design should be further investigated – and perhaps replicated in the main study.

At the onset of gameplay, participants encountered a mixture of emotions, notably stemming from the physicality of interactions. The intuitive nature of basic actions, such as opening shelves and handling items, induced feelings of engagement and excitement. Participants liked all the basic mechanics, as they allowed for exploration of the environment and simplicity because of the underlying understanding on how things already work – they know how to open drawers, or to cook a hotdog they need to find a hotdog (in fridge or freezer), then they can turn on the grill to cook them. Replicating this idea of form follows function, also found in usability design, seems to be the most appropriate approach for VR mechanics and interactions, because of the realistic nature of VR environments.

As gameplay progressed, the emotional landscape evolved in tandem. The emergence of performative behaviour and social interaction added layers of joy, amusement, and immersion. Participants embraced a wide range of emotional expressions, from playful interactions like finger guns and playful gestures, to more intricate responses such as engaging in one-way conversations with virtual characters. This part in the design process brings about complexities, especially contingent upon the specific nature of the game. For instance, within the light-hearted and comical ambiance of Job Simulator, the inclusion of such interactive freedom, whether through nuanced hand tracking or humorous dialogues, can profoundly amplify the emotions derived from the fundamental interactions within the game.

This propensity for positive reception stems from a multitude of factors. Based on how participants reaction, players appreciate the autonomy granted by such interactive dynamics.

However, it’s crucial not to underestimate the significance of even the most basic environmental elements. Take, for example, the frustration stemming from the absence of a bin for cleaning. While the absence of a simple bin might appear trivial, within the immersive and realistic context of VR, these seemingly minor inconveniences can significantly magnify emotional responses. In the realm of VR, such details are not transient; they become intensified due to the heightened sense of presence and interaction. This underscores the importance of considering the full spectrum of player experiences and preferences when designing the immediate virtual environment.

As the pilot study reached its conclusion, it became evident that emotional responses were intensifying, albeit taking diverse paths. Participants who quickly got used to the VR environment found themselves encountering boredom. This unexpected reaction shed light on the potential need for a dynamic and adaptable pacing mechanism that caters to individual performance levels. On the contrary, another group of participants found themselves elated with the VR experience. They relished the freedom to navigate at their own pace, continuously exploring new avenues within the virtual space.

This disparity in emotional trajectories signifies the multifaceted nature of player engagement within VR. It emphasizes that the emotional landscape can be a different journey for everyone, and finding the balance is important to achieve a balanced emotional response in all players. The ability of VR to evoke both boredom and elation underscores the malleability of emotional responses in this immersive medium.

In this context, game designers find themselves at a crossroads, with room for diverse approaches. The spectrum of emotions observed at the end of the pilot study highlights the significance of tailoring pacing strategies and player interactions to the unique dynamics of VR. This, in turn, opens up avenues for innovative design choices that can influence the emotional journey of players in distinct ways.

6.4.1.1 Specific Mechanics

One mechanic that notably elicited enthusiastic responses, often accompanied by exclamations like "Oooh!" and "Cool!", was the slushie machine. This effect was particularly pronounced among those who stumbled upon the realization that they could employ both hands or delve further into interactions, such as blending slushie colours or pouring the liquid out of cups. This observation offers several potential insights. For instance, the utilization of two hands, and thus heightened physicality in the interaction of the mechanic, might amplify the physical engagement, thereby intensifying the emotional response. Alternatively, the delight triggered could be attributed to the unanticipated discovery of realistic liquid physics within the virtual environment, sparking a surge of joy among players. In either case, these instances provide valuable starting points for enhancing arousal and cultivating positive emotions.

Another noteworthy mechanic introduced was the Jumbo-tron. This element comprised a compact platform equipped with a front-facing button. When players positioned items on this platform and pressed the button, the item would transform into an enlarged version, termed ‘jumbo’. This unexpected feature demonstrated its ability to trigger an elevated level of excitement upon discovery. This phenomenon can be attributed to the element of surprise within an environment predominantly characterized by anticipated interactions. The appearance of novel and unexpected elements during gameplay seemed to punctuate the experience with spikes in arousal. This strategic introduction of surprise acted as a countermeasure against a potential decline in engagement, ensuring players remained engaged and not drifting towards a state of boredom.

6.4.2 Player Types

The analysis of player types in the pilot study revealed a relatively even distribution among the participants, with a few exceptions. Most participants exhibited a diverse range of player types, indicating a balanced representation of different gaming preferences and behaviours.

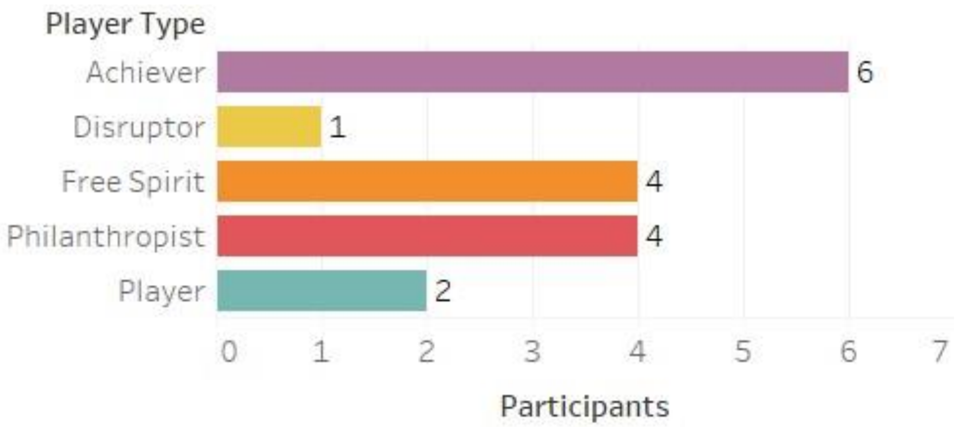


Figure 46 Overall Player Types in Pilot Study

However, it is worth noting that there were fewer participants classified as disruptors, a player type characterised by seeking novel and unconventional experiences. This may have been due to the limited sample size or specific demographics of the participants involved in the pilot study. The spread of player types in participants can be found in **Figure 46.**

Conversely, a significant portion of the participants fell into the player category, which represents individuals who engage in games primarily for enjoyment and entertainment. This distribution aligns with the broader gaming population and suggests that the pilot study captured a representative sample of players with varied preferences and motivations.

The even spread of player types, with the exception of fewer disruptors, provides insights into the potential influence of different player profiles on emotional responses in VR experiences. By examining how different player types engage with and respond to the VR prototypes, it becomes possible to discern patterns and identify any variations in emotional experiences associated with specific player profiles.

Considering the small amount of data collected for disruptors and the dominance of players in the pilot study, further investigation is necessary to explore the unique characteristics and emotional responses of disruptors within the framework. Expanding the sample size and ensuring a more balanced representation of player types in future studies would enhance the validity and generalizability of the findings.

In conclusion, the analysis of player types in the pilot study indicated a relatively even distribution among the participants, except for a smaller number of disruptors and a significant representation of players. These findings underscore the importance of considering player profiles when examining emotional responses in VR experiences. However, given the limited number of disruptors, further research is required to gain a more comprehensive understanding of their distinct emotional experiences within the framework.

6.5 Summary and Revision

In the pilot study, participants embarked on a journey within the store clerk level of *Job Simulator* (2016)*,* offering insight into the players' emotional responses and reactions to mechanics. The exploration of interactions and experiences uncovered a multitude of emotions, both expected and unexpected, as participants engaged with the virtual environment.

The pilot study identified several key findings. The interplay of physicality in interactions, the dynamics of signifiers and clarity of objectives, the emergence of performative behaviour, and the influence of social interactions collectively painted a vivid picture of the emotional landscape. Participants' responses to the absence of designated bins, the intrigue of the Jumbo-tron, and the immersive engagement with the slushie machine further enriched my understanding of how specific elements can incite emotional spikes.

The wide spectrum of emotional reactions stemming from the absence of the bin underscore the necessity for incorporating mechanics beyond those directly influencing gameplay. **Appendix B,** outlining the mechanics, required a broader inclusion of elements that contribute to the overall player experience.

Predominantly, the examples featured in the physics interaction mechanics revolved around dynamic physics systems in action-oriented games, centring primarily on weapon systems like guns, grenades, knives, bows, and the like. To delve deeper, I revisited my past VR gaming experiences, aiming to explore alternative interactions within the virtual environment. Through this exploration, I unearthed numerous instances of design elements that sparked feelings of joy without necessarily propelling the game's progression. These interactions enhanced the overall gameplay experience.

This outcome validates the significance of conducting the Pilot Study and improved my understanding of the proposed framework. Moreover, it enabled me to carry forward the insights gained from the study into the design refinement of my initial prototype.

Moreover, the journey through exploratory versus task-focused behaviour highlighted the gamut of player preferences, indicating the intricate balance between individual tendencies and the game's mechanics. As players progressed from initiation to culmination, the emotional pendulum swung between curiosity, engagement, amusement, and even boredom. This emotional progression showcased the potential for carefully curated gameplay to invoke diverse emotional states, ensuring sustained engagement, but also showcased the potential for monotony, an important consideration for future design.

However, due to overlaps in emotional responses and unclear participant feedback, there was a necessity to reassess emotional evaluations with participants. This issue was tackled in the main study by prioritizing questionnaires as the primary method to record emotional responses, while interviews served as supplementary. Furthermore, the Circumplex Model of Affect was utilized, enabling participants to explicitly map their emotions. This approach aimed to mitigate potential misunderstandings and overlaps encountered during the pilot study.

Additionally, the data collected on player types was insufficient to draw definite conclusions, and therefore, it was not integrated into the prototype design framework for the design process of the prototypes I would make. The anticipation was that the primary study would encompass a wider range of player types, allowing for the identification of influences and a deeper grasp of how they could align with the thesis framework, and allowing for further framework revision at the end of the study to address my secondary research question.

In summary, the pilot study served as a prelude, providing insight into the different emotional experiences players encounter in the virtual domain. The emotional evaluation phase shed light on potential issues concerning participants' emotions, prompting a re-evaluation of this process for the main study. The discernment of effective and ineffective mechanics, along with the thematic analysis of mechanics and participants' responses will serve as guidance and inform the design of mechanics in my own prototypes.

Chapter 7: Main Study Results & Discussion

7.1 Introduction

This chapter aims to present a thorough analysis and discussion of the results obtained from the main study conducted as part of this thesis. The main study involved playtesting two VR prototypes designed using the framework outlined in this thesis. Before delving into the results and discussion, the methods will be detailed for the entire study, broken down into each type. Subsequently, the results of prototype one, along with the data and thematic analysis, will be presented followed by a discussion. This will be followed by the results of prototype two using the same approach, followed by its discussion. The chapter will conclude with a summary of findings, encompassing the performance of the framework and the effect of player types.

The data is initially presented in each prototype's results section, while additional visualizations of the data will be provided in the discussion sections. Each prototype will be exploring the emotional journey of the participants – identifying the overarching emotions – as well as the individual emotions associated with each mechanic.

7.2 Methods

The main study involved several methods split up into various stages: an initial survey, observations, and recordings during gameplay, followed by a questionnaire administered at the conclusion of each prototype. Finally, an interview was conducted at the study's culmination. Details regarding each method and their corresponding outcomes are elaborated upon in subsequent subsections, paving the way for an analysis.

The outcomes obtained from each method will be discussed separately within their respective subsections in the results section. However, the data derived from observations and recordings will be integrated with the interview findings. This approach is adopted to facilitate a comprehensive understanding of the results, as these elements complement each other in providing insights.

The analysis method involved thematic analysis, aimed at identifying common themes in the data to discern emotional responses. Thematic analysis was conducted on the questionnaires in the main study, versus the interviews in the Pilot Study. This is because the main study's questionnaire was design to collect more detailed and comprehensive data than the Pilot Study's questionnaire.

The main study's interviews were used to help support the questionnaire, and make sure I understood the explanations and data given by participants on their questionnaires.

7.2.1 Session Schedules

Each session commenced with necessary paperwork, including the Consent Form, Participant Information Sheet, and Beck Anxiety Inventory. In contrast to the Pilot Study, participants filled out the questionnaires after engaging with each prototype. Nonetheless, these questionnaires were more extensive and time-consuming, consisting of two forms compared to the Pilot Study's single questionnaire. Consequently, the time allocated for paperwork during each session was considerably extended.

Throughout the Main Study, sessions usually spanned about two hours. Each session commenced with fifteen minutes allocated for paperwork and five minutes for setting up VR. This was followed by twenty minutes devoted to playing prototype one, and ten minutes for questionnaire one. Subsequently, participants engaged in twenty minutes of gameplay with prototype two, followed by another ten minutes for questionnaire two. Finally, the session concluded with an interview, with the length of the interview dependent on the clarity of questionnaire responses (around five to ten minutes long). Towards the upper end of these time estimates, sessions approached just under two hours in duration. The extra time was consistently filled for various reasons, such as longer VR setup or participants spending more time on questionnaires.

On average, I conducted sessions with four participants per day. Flexibility was required throughout the whole study due to potential technical issues, such as problems with VR connection, potential VR battery issues, etc.

Time was allocated between sessions for cleaning and adhering to COVID safety protocols. Additionally, optional breaks were provided during each session to accommodate participants experiencing motion sickness or dizziness. Participants were also informed of their right to withdraw or halt the session at any point.

7.2.2 Questionnaire

The questionnaire consisted of two sections, with the front side dedicated to questions regarding prototype one, while the back side was for prototype two. Both sides featured a Circumplex Model of Affect, with question number one asking participants to plot their emotional journey, as seen in **Figure 47**.

The remainder of **Figure 45** displays the second part of page one, consisting of a five-point Likert scale evaluation of the mechanics, followed by the option for participants to provide more detailed notes.

It is important to note that although participants were instructed to plot three points for question one, they were encouraged to add additional points if they felt any mechanic deviated from this journey or had a strong impact on them. Furthermore, eighteen participants added notes and comments beside their points to provide further explanation of their feelings. These quotes and comments will be discussed in section **7.3.2**.

1. Plot three points to what emotions you felt at the start, middle, and end of the playthrough (labelled 1 for start, 2 for middle, and 3 for end).
2. List on a scale of 1 to 5, with 1 being calm and 5 being excited, your emotional response when you first experienced them:

Mechanics	**Emotional Response (1=calm,5=excited)**
Unpacking items from box	
Sweeping dirt with broom	
Throwing items away	
Putting items away	
Getting a glass of water	
Discovering new items	

3. If any were not listed above and you feel they should be mentioned, please do so here:

Figure 47 Questionnaire for Prototype One

While question one on page two, which pertained to the evaluation of prototype two, remained identical to the original question one, mapping emotions to a Circumplex Model, the table of mechanics underwent changes, as shown in **Figure 48**. Additionally, the mechanics table provided participants with further options to choose between tension and excitement, featuring two separate columns. Furthermore, participants were encouraged to provide additional notes regarding the clarity of their tension, which will be discussed further when the results are presented.

Mechanics	**Emotional Response (1=calm,5=excited)**	**Emotional Response (1=calm,5=tense)**
Discovering the bow		
Using the bow		
Destroying the bottles		
Hunting the deer		
Hitting the deer with arrows		
Hunting the rabbit		
Hitting the rabbit with arrows		
Hunting the wolf		
Hitting the wolf with arrows		
Hunting the bear		
Hitting the bear with arrows		
Discovering the map		

Figure 48 Questionnaire Portion for Prototype Two

One last question was introduced for prototype two, asking participants their preference on smooth movement versus teleport movement. Both choices were readily available from the outset of prototype two, with the game starting with a brief audio introduction explaining how to utilize either option. In instances where participants encountered difficulty understanding the mechanics, I intervened to provide additional guidance. This was included to better understand whether there were huge discrepancies between the locomotion options, and if it impacted gameplay and immersion. There was no notable impact, and was thus not expanded upon in the discussion.

7.2.3 Interview Questions

The interview questions for the main study were less comprehensive than the Pilot Study, as the majority of the data was collected through the questionnaires. The interview served to clarify the information presented on the questionnaires, as well as facilitate a discussion of a participant's notes.

General Interview Questions (mostly guided by questionnaire responses)
Would you like to expand more on any mechanic or interaction that does not fit into the emotional journey you have mapped?
Can you expand a bit more on this point you have made on your questionnaire regarding the first/second prototype?
Can you clarify if there was any emotional deviation from the scales in the mechanics' table?
Is there anything else you would like to add?

Figure 49 Interview Questions for Main Study

7.2.4 Observations

In the main study, observations were conducted following a similar approach to that of the pilot study. To minimize any potential influence on the participants, I positioned myself outside the play area, maintaining a suitable distance and creating a barrier between myself and the participants. This allowed for discreet observation without directly impacting the participants' experiences. I sat behind a table near the entrance, enabling me to make notes during the play session. These observations were later verified by reviewing recordings of the session, ensuring accurate documentation of participant behaviors and interactions. Observations were used to support the conclusions drawn from the questionnaires and interviews, and are thus combined with the interview data in the results section in **7.3.2**.

7.3 Results [Prototype One]

7.3.1 Questionnaires

Prior to delving into the visualisations of trends in the results, I have presented the results in a tabular format sourced from Excel, showcasing participants' emotional responses. This presentation is exemplified in **Figure 50**. This format is well-suited for precise data observation, allowing for the identification of exact values provided by participants and the recognition of outliers.

Emotions (1=calm, 5=excited)						
Participant ID	Unpacking items from box	Sweeping dirt with broom	Throwing items away	Putting items away	Getting glass of water	Discovering new items
1	5	4	3	4	3	5
2	2	2	3	2	3	3
3	1	2	4	1	2	4
4	3	1	5	3	2	4
5	1	1	1	2	2	2
6	2	4	3	1	5	5
7	1	2	2	1	2	3
8	4	3	4	2	1	5
9	3	2	5	3	5	1
10	4	2	4	4	5	5
11	2	1	2	2	3	2
12	1	1	4	1	5	3
13	3	5	5	5	5	5
14	1	n/a	5	3	1	5
15	1	2	2	1	1	11
16	1	2	2	1	3	5
17	2	3	4	2	4	5
18	2	4	3	2	3	4
19	1	4	2	1	2	3
20	3	5	4	3	2	5
21	5	2	5	3	1	5
22	3	3	2	4	4	5
23	2	2	3	1	4	3
24	2	1	4	2	3	3
25	3	2	3	5	7	5

Figure 50 Participants Responses to Individual Mechanics of Prototype One

To map the emotional journey of participants, the questionnaires for each prototype had participants plotting their emotions on the Circumplex Model of Affect for their emotional state at the start, middle, and end of the play experience. For reference, the quadrants act as mathematical quadrant labelling, which can be seen in **Figure 40.** previously introduced in the Pilot Study Discussion in **6.3.1.2.**

The analysis of quad responses throughout the play session in Prototype 1 provides insights into the emotional dynamics and shifts experienced by participants, and can be found in **Figure 51**.

Quadrant	Number of Participants
Start	
1	11
2	1
3	1
4	12
Middle	
1	15
2	2
3	1
4	7
End	
1	6
2	2
3	2
4	11

Figure 51 Emotional Journey by Quadrant for Prototype One

7.3.2 Interviews with observations/recordings

For the interviews in the main study, I set to categorize responses into their quadrants, using the quadrants as emotional themes and thus implementing thematic analysis. Due to the majority of data being collected via the questionnaires with participants mapping their own emotional responses versus the pilot study relying on interviews, the interviews here are supplementary data. Therefore, a table has been assembled, seen in **Figure 52**, of quotes and instances participants expressed emotions from each quadrant, with further expansion on the individual mechanics that brought about these emotions.

Quadrant 1 – Excited/fun
“Since it was my first time trying VR, it was exciting mostly from the beginning to he end”
"Discovering new items, throwing items away, glass of water" – made participant excited
"Especially most interesting/exciting thing for me was to be able to throw objects to wherever I want" – realistic physics
"Toy box reminds me of a reference to a meme, where a lady frowns over every piece of jigsaws placed through same hole" -puzzle box
“It was fun watering the plants. I also liked pushing the button.”
Quadrant 2 – Tense/Frustrated
N/A – no responses identified emotions in this term directly via quotes/observable actions
Quadrant 3 – Puzzled/Curious

“I had the urge to explore more physics interactions” – realistic physics
Quadrant 4 – Calm/Relaxed/Entertained
"Button – feeling of breaking the cycle/rebelling”
“Plants: an expected joy"
"The water physics gave me a sense of Agency. It also runs out!"
"Tidying up the place is relaxing, like how it is in real life"

Figure 52 Quotes for Prototype One Mechanics Mapped to Emotions

7.4 Discussion [Prototype One]

Prototype One focused on calming and positive emotions, aiming to create a relaxing environment for players. **Chapter 5** includes a more detailed breakdown and review of the individual mechanics in the prototype.

7.4.1 Emotional Responses to Mechanics

In Prototype 1, several VR mechanics were incorporated to elicit specific emotional responses related to feelings of calmness and happiness. The analysis of participant feedback revealed varying responses and preferences towards different mechanics, shedding light on their effectiveness in achieving the intended emotional states. The trends in the results can be found in **Figure 53.** Additionally, **Figure 54** shows all responses except outliers in the form of an area chart. This is useful to better visualize the number of participants scattered at each number.

Among the mechanics, throwing items away and getting a glass of water emerged as the most positively received by participants. These actions seemed to resonate well with the participants, evoking a sense of satisfaction and engagement. The act of discarding items and the simple interaction of obtaining a glass of water appeared to effectively contribute to the desired emotional experience of cleanliness, organisation, and refreshment. In this regard, it appears that considerations for the environment with mechanics that do not affect gameplay, such as being able to throw items away, did re-enforce the findings from the Pilot Study. Additionally, further prompting users to drink water appeared successful in evoking the emotions – even though this was a required task. This helps the framework development particularly for calmer emotions – if something calming is forced through some constraint (in this case a task), it can still elicit the calming effect it was designed for.

On the other hand, sweeping dirt with a broom received comparatively lower levels of enthusiasm from the participants. The feedback indicated that this mechanic did not evoke the same level of enjoyment or engagement as the other mechanics. It is important to consider potential factors that may have influenced this response, such as the perceived realism of the sweeping motion or the level of interactivity provided. The contradictory response, however, was that several players particularly enjoyed this mechanic far more than others, even highlighting it in their post-questionnaire and as auditory responses to the researcher afterwards.

Overall, this mechanic was hard to place. The framework initially indicated mechanics involving both hands, or overly hands on, would do well. However, this specific mechanic introduces the possibility that individual player preferences could potentially alter this conclusion, rendering it less dependable.

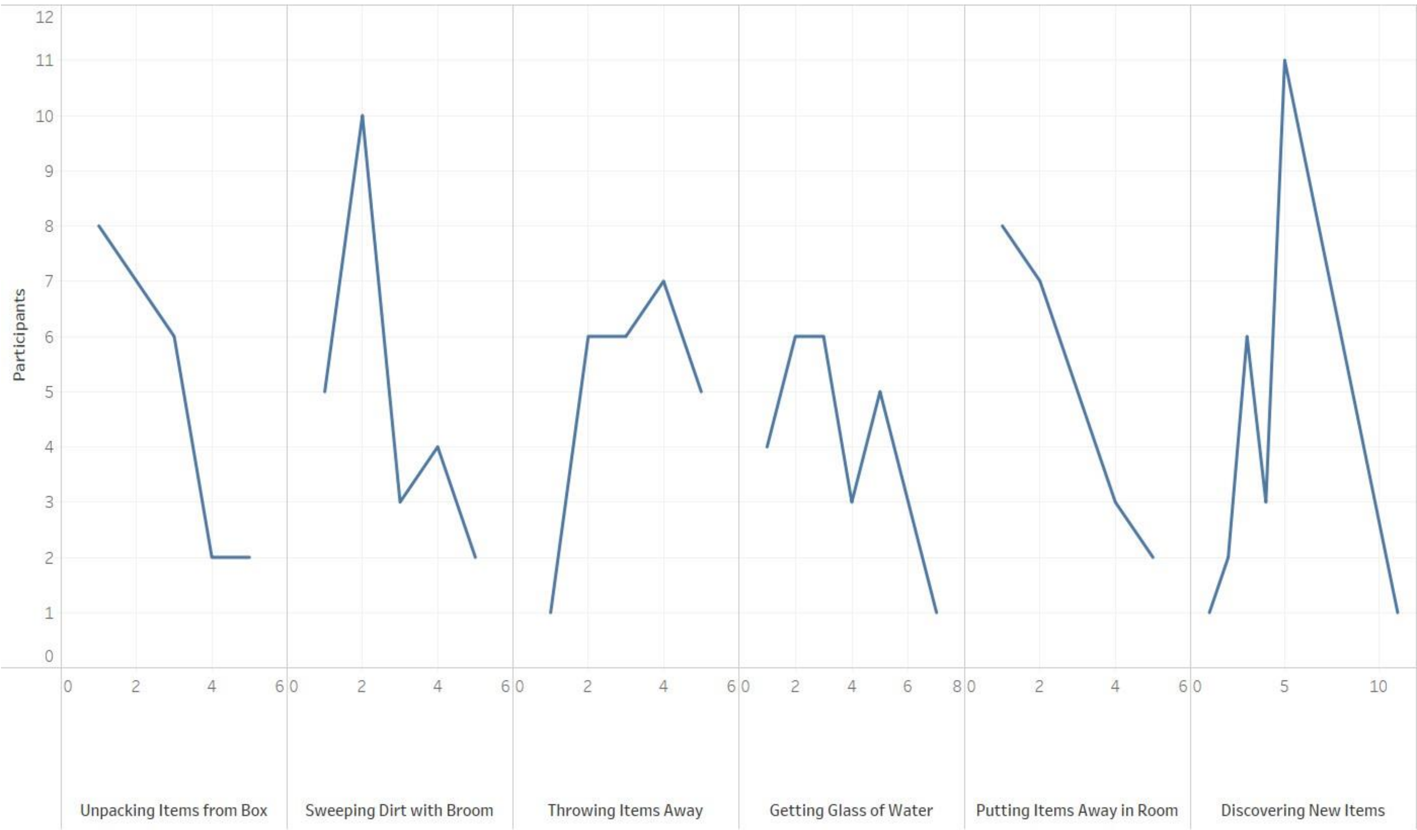


Figure 53 Emotional Responses on Likert Scale (1-5: Calm to Excited)

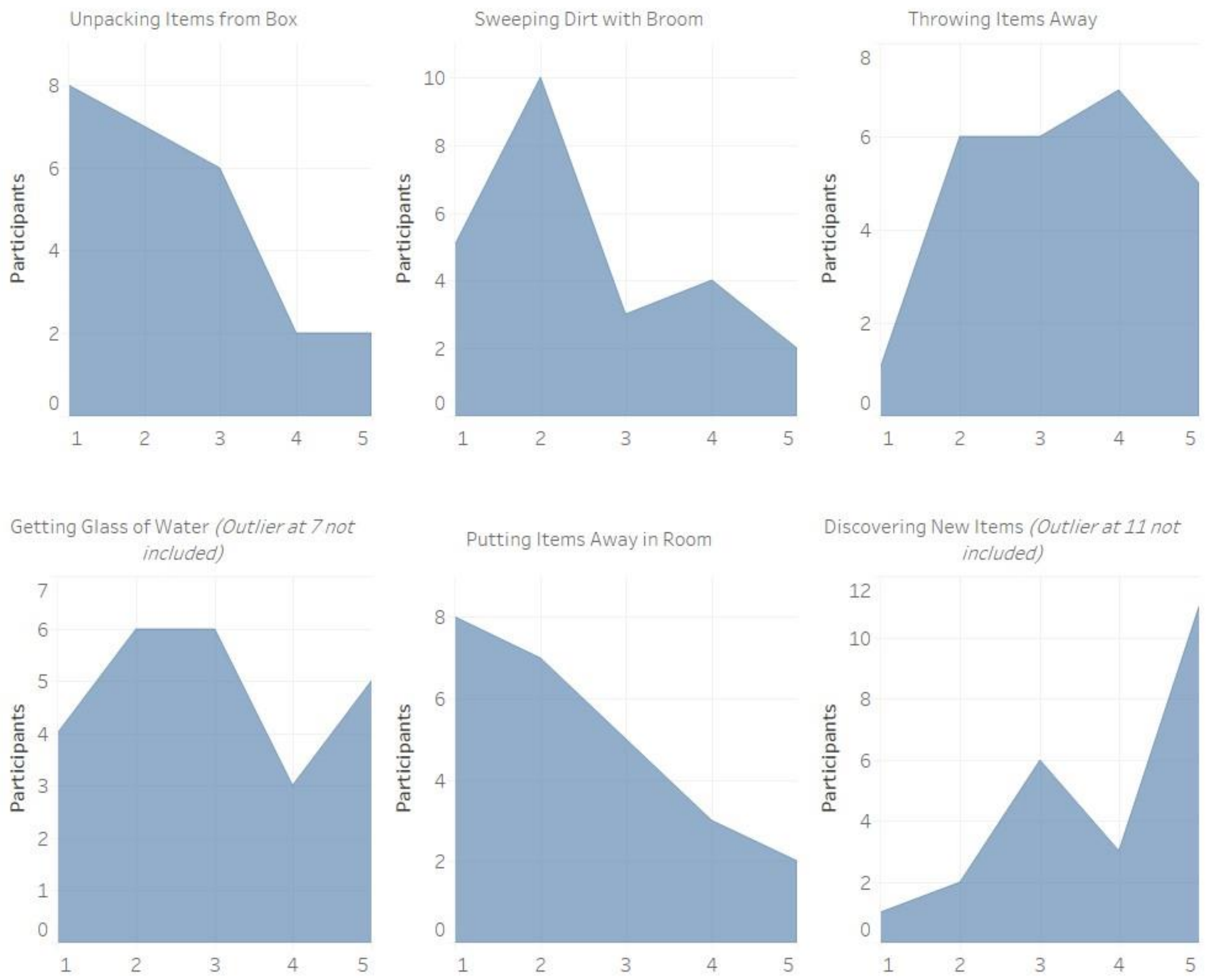


Figure 54 Emotional Responses as Area Chart for Prototype One Mechanics

The mechanic of putting away items generated a neutral response overall. While it did not elicit particularly strong positive or negative emotions, it still contributed to the overall experience of organisation and tidiness, and seemed to provide an overarching comfort that players could have the freedom in manipulating their environment and its appearance. This feeling can be observed in non-VR games, particularly with the inspiration for this prototype – *Unpacking* (2021). The game *Unpacking* (2021), which involves arranging items in a new home, triggers similar feelings of organisation and comfort. This alignment in emotional responses reinforces the efficacy of the storage mechanic in evoking a sense of control and satisfaction.

Furthermore, VR has the potential to induce calming emotions through repetition. An instance from **Appendix B**, demonstrated by *Ragnarock'*s (Wanadev Studio, 2021) repetitive drumming mechanic, reveals that engaging in repetitive actions combined with the physical exertion involved can evoke a calming effect. This observation strengthens the notion that the repeated action of storing items might establish a soothing cycle. If repetition is a common element in inducing a sense of calm, it could also provide reinforcement for some mechanics already present in the framework.

The mechanic of discovering new items displayed a more mixed response. This suggests that the impact of this mechanic on the emotional experience was more diverse among the participants. While some individuals expressed high levels of enjoyment and curiosity when discovering new items, others had more moderate or indifferent responses. This diversity in feedback is reflected in both the average and median ratings for this mechanic.

This mixed finding was not able to provide enough feedback to adjust my framework. However, this contrasts my findings in VR games – for example finding a new weapon to use in *Walking Dead: Saints & Sinners* (2020). With these discoveries I certainly felt heightened arousal and thus excitement. This also appeared as a consensus in interviews during the pilot study – peaks in arousal, even if minute, were present on discovering new interactions. Therefore, perhaps the complexity of the item, or its place in the narrative of the game, affect the degree of emotional response elicited – this implies that certain mechanics in **Appendix B** require further elaboration and depth.

7.2.1.1 Average vs. Median: Evaluating Mechanics Performance

In the evaluation of the performance of each VR mechanics in both the pilot study and the main study, it is important to consider both the average and median values. These statistical measures provide distinct perspectives on the central tendency of the data and offer insights into the overall effectiveness of the VR experiences.

The average, or mean, is commonly used to calculate the sum of all data points divided by the total number of participants. It provides a measure of the typical or average emotional response within the sample. By analysing the average values, we can gain a sense of the general emotional impact that the VR mechanics have on the participants as a whole.

However, relying solely on the average can be misleading, as extreme values or outliers may heavily influence the calculation. This is particularly relevant in studies involving emotions, where individuals may exhibit highly varied responses. To address this concern, the median is employed as an alternative measure of central tendency.

The median represents the middle value when all data points are arranged in order. It is less sensitive to extreme values, making it a robust indicator of the central tendency. By examining the median values, we can identify the emotional response experienced by the typical participant, regardless of any outliers or extreme values.

In the evaluation of the mechanics' performance, both the average and median values were considered to provide a comprehensive understanding of the emotional impact. The average values helped identify the general emotional trends and the overall effectiveness of the mechanics, while the median values provided insights into the typical emotional response experienced by the majority of participants. By utilizing both statistical measures, a more nuanced evaluation of the mechanics' performance was achieved, considering both the general emotional impact and the experiences of the majority of participants. The averages of each mechanics results is seen in **Figure 55**, while the median can be viewed in **Figure 56**.

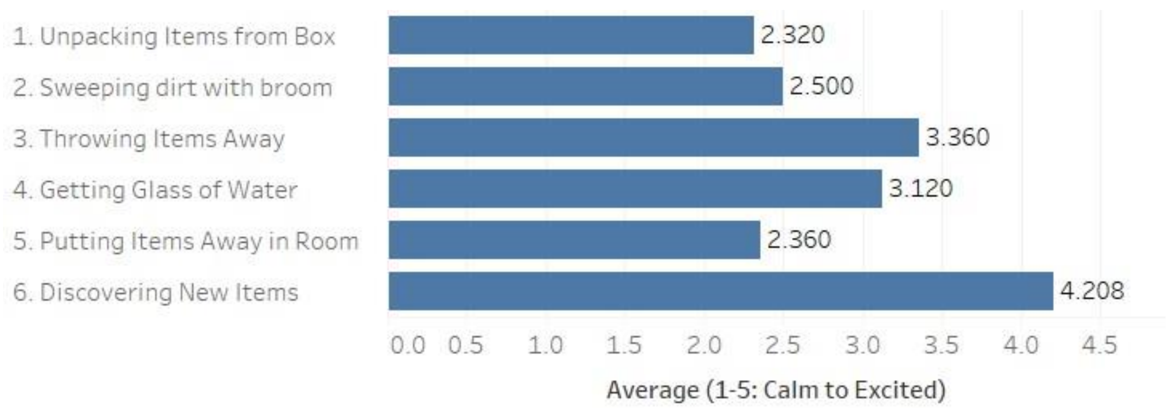


Figure 55 Averages of Emotional Responses for Prototype 1 Mechanics

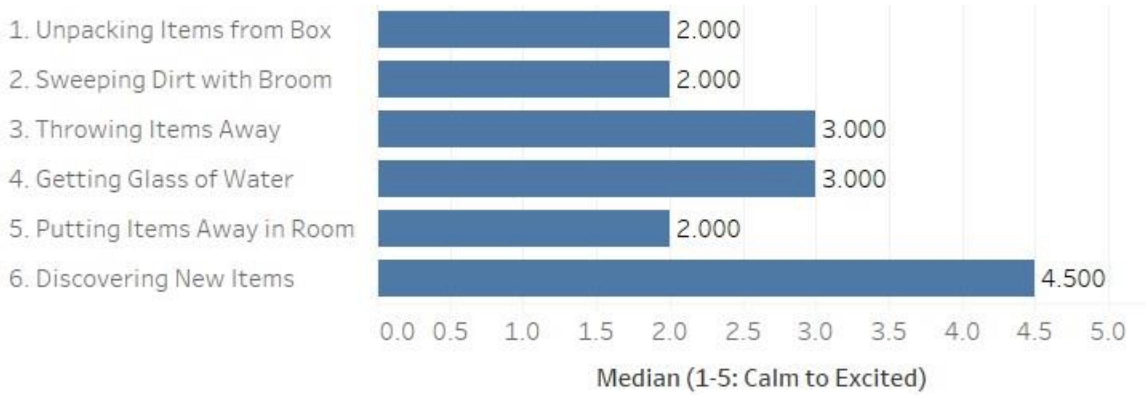


Figure 56 Medians of Emotional Responses for Prototype 1 Mechanics

Overall, the analysis of Prototype 1 mechanics indicates that the mechanics related to discovering new items, throwing items away, and getting a glass of water were more successful in eliciting the desired emotional states of calmness and happiness. These mechanics resonated with the participants, with discovering new items performing particularly well. On the other hand, the mechanic of sweeping dirt with a broom received relatively less enthusiasm overall, with only three stating otherwise. The act of putting away items generated a neutral response, neither strongly positive nor negative. Consistency was relative for the most part with the emotional responses.

These findings provide useful insights for further refining the framework and selecting mechanics that effectively contribute to the desired emotional experiences in VR. It helped me to identify areas that are lacking, as well as areas that have been supported from the findings. I am also able to refine the framework by addressing the areas that need more mechanics considered to provide other gameplay considerations.

7.4.2 Emotional Responses at Start, Middle, & End

Emotions were measured at the start, middle, and end of the play session, allowing for a comprehensive understanding of the emotional trajectory.

At the start of the play session, the majority of participants reported being in either a calm or excited state. This suggests that the VR experience in Prototype 1 had the potential to elicit a range of positive emotions, with participants either starting from a state of calmness or entering the experience already excited and engaged. The number of participants in each quadrant at these three points of the play experience can be found in **Figure 57**.

During the middle of the play session, there was a noticeable movement away from the calm quadrant towards the excitement quadrant. This indicates an increase in participants' arousal levels and suggests a shift towards more intense emotional states.

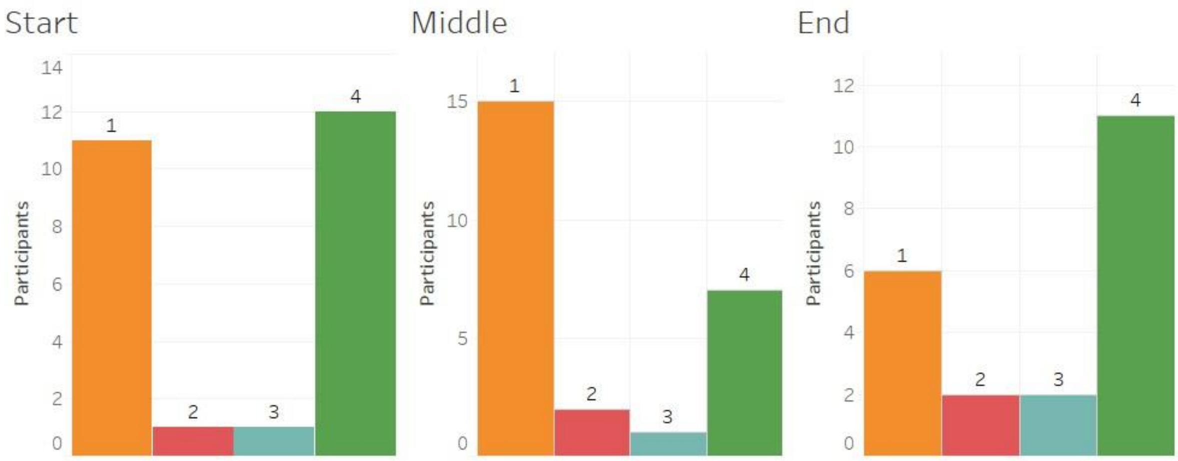


Figure 57 Emotional Responses by Quadrant at the Start, Middle, and End of Prototype One

Towards the end of the play session, there was a distinct movement away from the excitement quadrant and a shift towards the calm quadrant. This suggests a gradual return to a state of calmness and relaxation as the participants neared the conclusion of the VR experience. It is plausible that the calming elements within the mechanics or the winding down activities in Prototype 1 facilitated this shift towards a more tranquil emotional state.

These findings highlight the emotional dynamics experienced by participants during the play session of Prototype 1. The initial excitement and engagement transitioned into a gradual return to a state of calmness. This trajectory suggests that the VR experience successfully evoked a range of positive emotions, aligning with the desired emotional states of calmness and happiness.

Understanding these emotional shifts and the impact of the mechanics on participants' emotional experiences can inform future iterations of the framework. By strategically designing and sequencing mechanics to guide the emotional trajectory, developers can create more immersive and engaging VR experiences that effectively evoke the intended emotional responses.

In summary, the analysis of quad responses in Prototype 1 demonstrated a movement from calmness or excitement at the start, towards increased excitement during the middle, and a subsequent return to calmness towards the end. These findings underscore the emotional dynamics experienced by participants and highlight the success of the mechanics in evoking positive emotions aligned with the desired emotional states.

7.5 Results [Prototype Two]

7.5.1 Questionnaires

The missing participant responses for the end are due to several participants mapping only two points for their emotional journey. Through interviews, I was able to better address what these responses meant – they will be covered in the next subsection.

Prototype Two focused on tense emotions, aiming to create an atmosphere that keeps players on their feet and at the edge with anticipation. **Chapter 5** includes a more detailed breakdown and review of the individual mechanics in the prototype.

As was done in the previous section, prior to delving into the visualisations of data trends for Prototype Two, the precise participant responses are provided in **Figure 58.** However, this table presents slightly modified values – the entries highlighted in yellow correspond to participants who leaned more towards excitement than tension in their identification. It's important to note that although this subset of participants displayed a preference for emotions closer to excitement, their expressions also contained elements of tension. Despite the subtle difference in their leaning, their positioning was very close to the y-axis, indicating a potential for fluctuation between excitement and tension. The impact of this distinction on the overall mechanics results appeared to be minimal.

Furthermore, it's intriguing to observe that all these participants mentioned a preference for high-intensity action games and FPS games. While this observation didn't significantly affect the mechanics' results, it does raise interesting prospects for further inquiry into different player types and their perceptions.

Emotions (1=calm, 5=tense/alert)												
Discovering the bow	Using the bow	Destroying bottles	Hitting target practice	Hunting the deer	Hitting deer w/ arrows	Hunting rabbit	Hunting rabbit w/ arrows	Hunting wolf	Hitting wolf w/ arrows	Hunting bear	Hitting bear w/ arrows	Discovering map
4	5	4	4	5	5	5	5	5	5	5	5	4
1	3	2	1	1	1	1	1	4	5	5	5	2
1	3	3	3	3	1	3	1	2	1	5	1	1
5	4	0	2	3	3	3	3	3	3	4	5	2
5	3	4	2	3	2	2	2	4	3	5	4	1
1	2	1	1	2	1	3	3	4	3	4	3	4
1	3	2	2	3	2	4	2	4	4	4	5	1
1	2	1	2	3	2	4	3	5	4	5	5	3
4	3	1	1	3	3	3	3	4	5	5	5	2
5	5	3	2	1	2	2	2	4	5	5	5	3
1	3	2	3	1	2	1	1	1	3	1	4	4
1	1	1	1	2	2	2	4	3	5	5	3	1
3	5	5	5	2	2	2	2	5	5	4	5	2
5	5	5	5	2	4	2	4	3	4	4	5	1
1	2	1	2	1	1	1	1	1	3	1	3	1
2	4	2	3	4	5	3	4	5	4	5	4	2
3	5	2	5	4	5	4	5	5	5	5	5	2
4	5	3	4	3	2	4	4	5	5	5	5	3
1	1	1	1	1	3	1	1	4	3	5	4	1
1	1	3	3	3	5	3	4	4	5	5	5	n/a
1	2	2	1	3	1	3	4	5	1	5	1	2
2	3	1	3	3	3	3	3	4	3	2	2	1
4	3	2	5	5	3	5	3	5	3	5	5	3
2	3	4	3	2	3	4	5	5	4	5	4	2
1	1	1	1	4	2	3	1	5	3	3	5	7

Figure 58 Emotional Responses to Individual Mechanics in Prototype Two

Additionally, the overarching emotional responses based on participants' mapping their journey via the Circumplex model of Affect can be found in **Figure 59.**

Quadrant	Number of Participants
Start	
1	16
2	1
3	0
4	8
Middle	
1	14
2	3
3	2
4	4
End	
1	8
2	9
3	0
4	1

Figure 59 Emotional Journey by Quadrant for Prototype Two

7.5.2 Interviews with Observations/Recordings

For the interviews conducted in the main study, I aimed to categorize responses into their respective quadrants on the Circumplex Model of Affect, utilizing the quadrants as emotional themes and implementing thematic analysis. However, since the majority of data were collected via questionnaires where participants mapped their own emotional responses, as opposed to relying on interviews like in the pilot study, the interviews here serve as supplementary data. Therefore, the data has been compiled in **Figure 60**, containing quotes and instances where participants expressed emotions from each quadrant. Additionally, further elaboration on the individual mechanics that elicited these emotions is provided.

Quadrant 1 – Excited/fun
"I liked that I could climb the hills." – open environment
"Most of my emotions were excitement once I got used to the bow." – bow
"It was fun and since it was skill based, I liked working towards getting better." – bow
"I tried to shoot bottles I threw into the air, like in [the] movies" – realistic physics
Quadrant 2 – Tense/Frustrated
"When the wolf ran towards me, but [I] got used to it quickly." – higher mastery level

"The wolf and the bear were tense and a challenge to beat, they provided a threat."- higher mastery level
“I don’t like killing the animals” – two participants expressed discomfort with hunting animals
Quadrant 3 – Puzzled/Curious
N/A – participants focused on more intense emotions with higher arousal, whether that be more positive such as excitement, or more negative such as tense
Quadrant 4 – Calm/Relaxed/Entertained
"I was the most calm when discovering the bow and map, target practice and rabbit/deer interactions." – lower mastery level

Figure 60 Quotes for Prototype Two Mechanics Mapped to Emotions

Based on these quotes, the realistic physics and using the bow, alongside an open environment, brought about excitement and joy, whereas the mastery level was able to bring about a transition from calm to tense. To delve deeper into these observed trends, the forthcoming section will analyse the data in detail.

7.6 Discussion [Prototype Two]

7.6.1 Emotional Responses to Mechanics

Prototype 2 aimed to elicit tense emotions, and the mechanics incorporated in this VR experience were specifically designed to evoke these emotional states. The analysis of participant feedback provides insights into the effectiveness of each mechanic in achieving the intended emotional responses. The emotional responses to each mechanic can be found as a visualization in **Figure 61.**

Among the mechanics, discovering the bow received a relatively neutral response from participants. This suggests that while the initial discovery of the bow may not have generated strong emotional reactions, it still served as an important element in setting the stage for the subsequent mechanics and gameplay.

Using the bow, on the other hand, was reported as much more enjoyable by participants. This mechanic successfully engaged participants and elicited a higher level of fun and satisfaction. The act of using the bow in the VR environment likely provided a sense of empowerment and control, contributing to the enjoyment and immersion of the experience.

These results from the discovery and use of the bow perfectly align with my understanding of VR mechanics from the framework I have made with existing games. It appears the action of using any weapon with even a small degree of physics evokes excitement and immediate exploratory urges. This could be explored further in the framework by looking at other tools – whether this applies to only weapons, or if other VR games with a focus on one main mechanic can achieve similar.

The mechanic of destroying bottles received a similarly neutral response from participants. While it did not evoke strong positive or negative emotions, it still contributed to the overall engagement and interactivity within the VR environment. Participants who discovered they could throw the bottle and break it were the main results of positive reactions. This backs up the framework through re-enforcing the joy that can be found in physics-based interactions, regardless of impact on core gameplay.

Hitting the target practice, which is closely related to using the bow, generated similar levels of enjoyment, albeit slightly lower compared to the act of using the bow itself. This indicates that the precision and accuracy required in hitting targets added an additional layer of challenge and engagement, contributing to the overall tense and immersive experience.

Hunting the various animals in Prototype 2 exhibited a range of responses. Hunting deer and hitting deer with arrows demonstrated a relatively balanced level of enjoyment, with slightly higher ratings for the act of hitting the deer with arrows. This suggests that participants found satisfaction in the successful execution of the hunting mechanics.

The mechanics of hunting the rabbit and hitting rabbit with arrows were reported as even more fun by participants. This may be attributed to the increased level of challenge and precision required when targeting and hitting smaller, more agile prey.

Hunting the wolf and hitting the wolf with arrows generated higher enjoyment ratings compared to the previous mechanics. The presence of a more formidable and dangerous prey likely contributed to the heightened sense of tension and excitement.

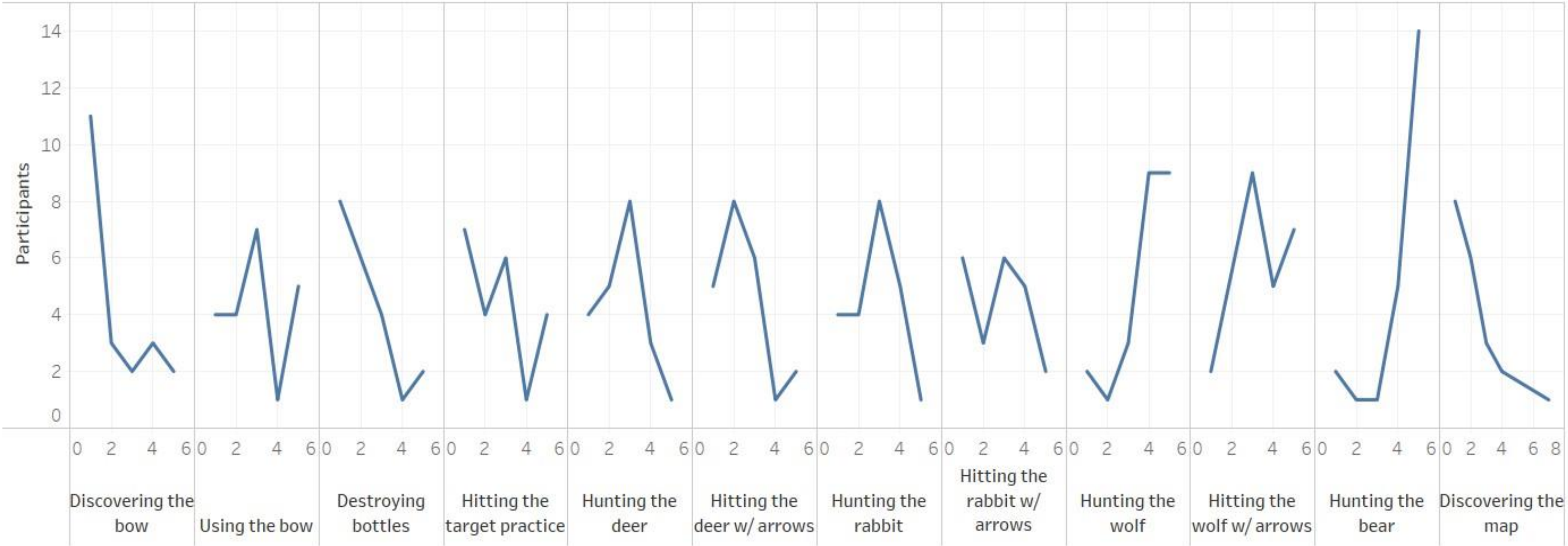


Figure 61 Emotional Responses to Mechanics in Prototype Two

Interestingly, hunting the bear received the highest average ratings among all the mechanics in Prototype 2. The mechanic of hitting the bear with arrows was also reported as particularly enjoyable. The presence of a large and powerful predator likely heightened the intensity and created a thrilling experience for participants.

Discovering the map, in contrast to the hunting mechanics, received a relatively neutral response from participants. While it served as an important element in navigating the VR environment, it did not generate strong emotional reactions compared to the other mechanics.

Analysing the average ratings seen in **Figure 62**, the mechanics of hunting the wolf and hunting the bear achieved the highest averages, closely followed by using the bow. This indicates that these mechanics were particularly successful in evoking tense emotions and creating engaging experiences. The median ratings seen in **Figure 63** further reinforced these findings, with the bear mechanics consistently ranking the highest, followed by the wolf, rabbit, and deer mechanics.

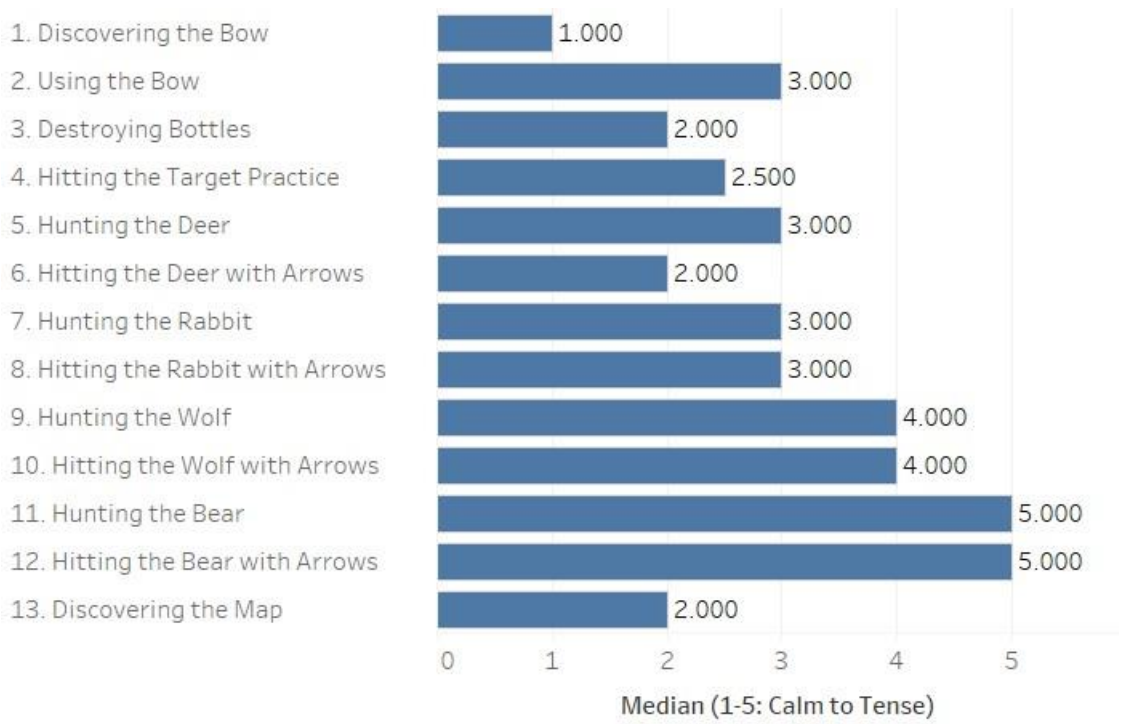


Figure 62 Average of Emotional Responses to Each Mechanic in Prototype Two

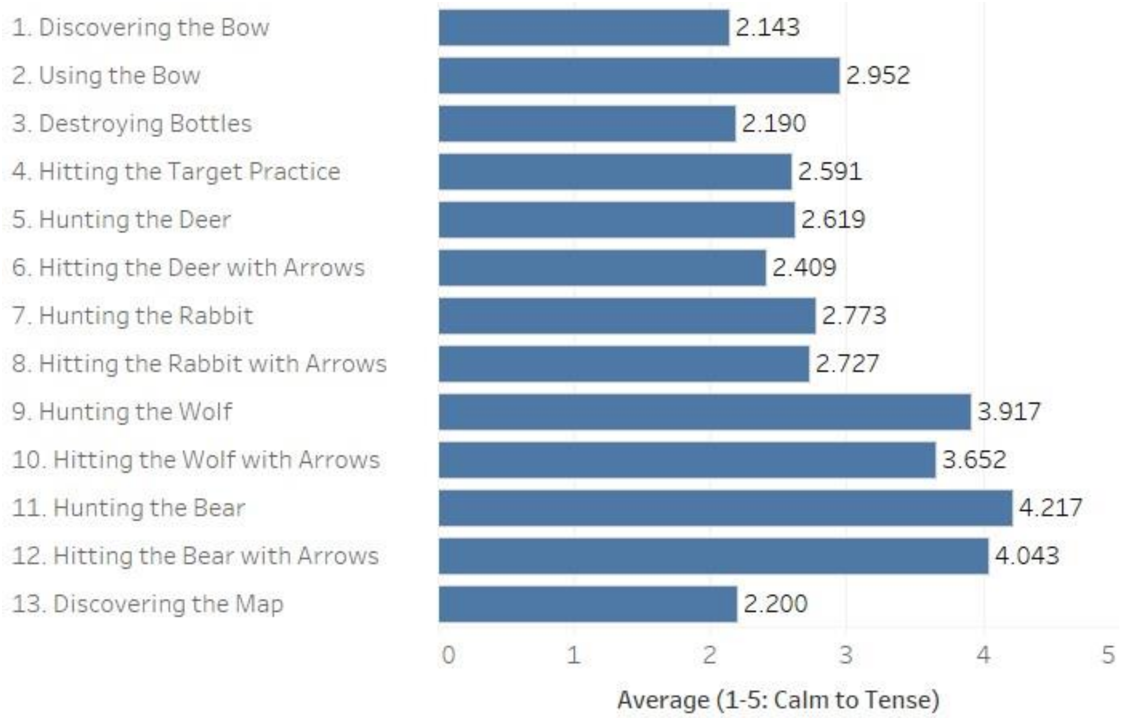


Figure 63 Median of Emotional Responses to Each Mechanic in Prototype Two

Overall, the analysis of Prototype 2 mechanics highlights the varying degrees of enjoyment and engagement reported by participants. Using the bow, hunting the wolf, and hunting the bear emerged as the most enjoyable and effective mechanics in eliciting tense emotions.

Considering the framework, consulting **Appendix B**, and delving deeper into VR game examples, it becomes evident that giving players little time to react, while also considering the opponent's speed or size, can intensify the tension experienced by players. The conclusions drawn from this prototype align with the framework, as heightened tension is mirrored in the gameplay's culmination.

The mechanics associated with hitting targets, hunting rabbits, and hunting deer also contribute to the immersive and engaging nature of the experience. These insights inform the ongoing refinement of the framework, offering feedback through both narrative context (some players did not like hunting animals) and the minimal tension they provided. With the heightened tension at the end, this serves as a valuable comparison and aids in identifying points of differentiation between each encounter – the rabbit, deer, and target ran away or did nothing to the player. Therefore, the predatory nature of the other animals could potentially provide the tension, once again indicating that narrative context can significantly impact the emotions elicited. While narrative was not a focus, it does help the framework to understand how something as simple as a certain kind of animal can change the emotional state of a player from calm to sad in an instant.

7.6.2 Emotional Responses at Start, Middle, & End

Analysing the quad responses throughout the play session in Prototype 2 provides insights into the emotional experiences and shifts reported by participants. By examining the distribution of quad responses at the start, middle, and end, I can identify patterns and changes in emotional states. A visualization of the results can be found in **Figure 64**.

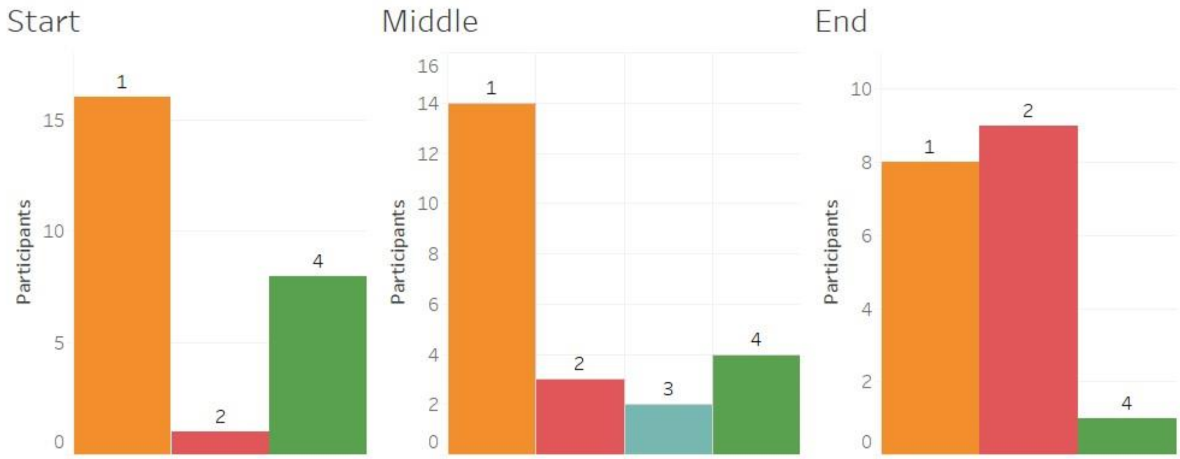


Figure 64 Overall Emotions at Start, Middle, and End via Quadrants in Prototype Two

At the start of the play session, the majority of participants reported being in the happy quad, with the remaining participants primarily in the calm quad. This indicates that participants entered the VR experience in Prototype 2 with a predominantly positive emotional state, characterised by feelings of happiness and contentment.

During the middle of the play session, there was a notable movement from the calm quad towards the tense or bored quads. This suggests a shift in emotional states, with participants experiencing increased tension or boredom as they progressed through the VR experience. The mechanics and gameplay elements designed to evoke tense emotions likely contributed to this shift in participants' emotional experiences.

Towards the end of the play session, there was a significant movement towards the tense quad from all other quads, including the happy and calm quads. This indicates a strong shift towards more intense and negative emotional states, aligning with the intended aim of Prototype 2 to elicit tense emotions. The culmination of the mechanics and narrative elements likely intensified participants' emotional responses and contributed to the overall immersive and tension-filled experience.

Regarding the narrative aspect, although not an intentional design focus and even deliberately minimized during the session, the introduction of animal hunting as a theme triggered feelings of sadness and negativity among several participants who did not wish to harm the animals.

In summary, the analysis of quad responses in Prototype 2 demonstrates a trajectory from predominantly positive emotional states at the start towards more intense and negative emotional states, particularly in the tense quad, at the end of the play session. This journey reflects the successful execution of the mechanics in eliciting tense emotions and creating an immersive VR experience.

7.7 Summary of Findings

The comprehensive analysis of the playtesting of Prototype 1 and Prototype 2 within the framework for VR mechanics that elicit targeted emotions has yielded valuable insights into the effectiveness of the framework and the influence of various factors on emotional experiences in virtual reality. The findings discussed in this chapter shed light on the trends, patterns, and variations observed within the data, providing a deeper understanding of the research objectives and implications for future development.

In Prototype 1, the mechanics implemented to evoke calmness and happiness yielded mixed responses from participants. While throwing items away and obtaining a glass of water were well-received, sweeping dirt with a broom generated lower levels of enthusiasm. The mechanics related to discovering new items exhibited a more diverse range of responses, suggesting the need for further investigation into individual preferences and emotional experiences. Furthermore, player types displayed varying preferences and levels of engagement with the mechanics, emphasising the importance of personalising the experiences based on player profiles.

Prototype 2, designed to evoke tense emotions, showcased mechanics that garnered different levels of enjoyment and engagement. Using the bow, hunting the wolf, and hunting the bear were particularly successful in eliciting tense emotions, while mechanics such as destroying bottles and discovering the map received more neutral responses. The influence of player types on these mechanics highlighted variations in preferences, with socializers displaying higher engagement in hunting mechanics. Additionally, the potential effect of narrative proved effective at altering certain player’s responses, not in conjunction with player types.

Quad responses in both Prototype 1 and Prototype 2 revealed dynamic emotional trajectories throughout the play sessions. Participants started with predominantly positive emotions, experienced shifts towards more intense emotional states in the middle, and ended with a significant increase in either calm or tension. These findings demonstrate the success of the VR experiences in eliciting the desired emotional responses each prototype were focused on, while also highlighting the need to carefully manage emotional trajectories for a satisfying and engaging user experience.

Considering the influence of player types on the overall findings, it is evident that individual preferences and emotional experiences vary across player profiles. While some trends and patterns emerged, such as players exhibiting lower responses and socializers displaying higher enjoyment in certain mechanics, it is important to recognize the diversity within player types and the potential for individual differences.

In summary, the outcomes derived from the playtesting of Prototype One and Prototype Two offer valuable insights into the framework's efficacy in crafting VR mechanics that evoke specific emotions. The scrutiny of mechanics, player responses, quadrant analyses, and broader trends contributes to a more profound comprehension of the emotional interplay within VR experiences. These findings pinpoint both successful facets and those requiring refinement for the framework's future. While certain mechanics within the framework might require greater depth – especially evident in physics-related examples predominantly centred on weapon usage, and general assumptions stemming from the pilot study's exploration of new interactions yielding arousal peaks – other aspects affirm the framework's effectiveness. The increased tension in Prototype Two's finale hint at this effectiveness, implying triumph in a particular mechanic – be it through constraints, narrative intricacies or tool utilization combined with AI. This is coupled with the success of Prototype One's maintained tranquility, potentially arising from repetition actions or even from the presence of a bin.

7.8 Performance of Framework

The framework for VR mechanics that elicit targeted emotions has demonstrated remarkable performance throughout the pilot study and the subsequent playtesting of Prototype One and Prototype Two. By effectively mapping the identified inputs from playtesting VR games to potential emotional responses using the circumplex model of affect, the framework has guided the design and implementation of mechanics aimed at eliciting specific emotional states. The analysis of participant feedback and quad responses has provided substantial evidence of the framework's effectiveness in achieving its intended goals. However, it is crucial to thoroughly examine both the strengths and limitations of the framework to fully comprehend its implications and areas for improvement.

One of the primary strengths of the framework lies in its ability to provide a structured approach to the design process. By incorporating the inputs derived from playtesting VR games and linking them to emotional responses, the framework offers a clear roadmap for designers to follow. This structured approach ensures that the mechanics integrated into the VR experiences align with the desired emotional outcomes. The framework's ability to cater to different player types further enhances its effectiveness, allows for personalised experiences that cater to individual preferences and motivations.

The analysis of quad responses has served as a powerful validation of the framework's effectiveness. By tracking the participants' emotional trajectories throughout the play sessions, the framework successfully elicited a range of emotions in line with the intended objectives. This comprehensive understanding of emotional dynamics within the VR experiences has laid the foundation for creating immersive and emotionally resonant virtual mechanics. The quad responses not only demonstrated the successful implementation of the framework but also provided valuable insights into the emotional journeys experienced by participants, offering possibilities for further exploration and refinement.

While the framework has exhibited promising performance, it is crucial to address its limitations and acknowledge potential areas for improvement. The relatively small sample size of participants involved in the main study and playtesting limits the generalizability of the findings. Future research should aim to include a larger and more diverse participant pool to enhance the validity and reliability of the framework's performance. Additionally, while the circumplex model of affect served as a stable foundation for mapping emotional responses, continued exploration and refinement of the mapping process could enhance the precision and accuracy of emotional design in VR.

In conclusion, the performance of the framework for VR mechanics that elicit targeted emotions has been highly encouraging. Its structured approach, coupled with the integration of player types, has facilitated the design and implementation of mechanics that successfully evoke specific emotional states. The analysis of participant feedback, quad responses, and emotional trajectories has provided practical insights into the framework's effectiveness and its potential to shape the future of VR game design. By addressing the identified limitations and continuing to refine the framework, researchers and designers can further enhance its performance and contribute to the advancement of emotionally immersive experiences in virtual reality.

7.9 Player Types

In this section, I will first discuss the data results for the player types identified for each prototype. Subsequently, a critical analysis of these findings will be presented, discussing both the positive aspects they show and any concerns they raise. Lastly, I will bring this analysis into a reflective discussion about the performance of player types and the decision on incorporating them into the framework.

7.9.1 Methods

Player types were identified using the HEXAD framework questionnaire responses at the beginning of each session. Subsequently, quotes from participants were categorized into their corresponding player types to uncover connections within the data and results.

7.9.2 Results

To initiate the presentation of results, **Figure 65** illustrates the distribution of player types among participants.

HEXAD Player Type	Number of Participants
Achiever	3
Free Spirit	6
Philanthropist	12
Player	2
Socializer	2

Figure 65 Player Types in Main Study

Due to the extended duration required for each individual session, encompassing playtime, interviews, questionnaires, etc., fewer participants could be accommodated. Consequently, with the uneven distribution of player types, drawing concrete conclusions becomes challenging. Despite efforts to utilize both questionnaire and interview data to support observations, for every potential point drawn, a counterpoint from another participant emerged. These contrasting perspectives will be substantiated with interview quotes. While these quotes were previously introduced to elucidate players' emotional responses, they have now been categorized into their respective player types in **Figure 66** and **Figure 67**, for prototype one and prototype two, respectively.

Player Type	Quote
Socialiser	It was fun watering the plants. I also liked pushing the button.
Free Spirit	one just confirmed pressing door bell was a 5”
Free Spirit	“[I liked] pressing the door bell”
Free Spirit	“Especially most interesting/exciting thing for me was to be able to throw objects to wherever I want”
Free Spirit	[I liked] Throwing the items on the shelf”
Free Spirit	“The water physics gave me a sense of Agency. It also runs out!”
Free Spirit	on the doorbell/button “feeling of breaking the cycle/rebelling -> Stanley Parable”
Free Spirit	“Plants: an expected joy”
Philanthropist	“Toy box reminds me of a reference to a meme, where a lady frowns over every piece of jigsaws placed through same hole

Figure 66 Player Types with Quotes from Prototype One

Player Type	Quote
Socialiser	“I liked that I could climb the hills”
Free Spirit, Philanthropist	disliked killing animals
Player	“Most of my emotions were excitement once I got used to the bow”
Player	“It was fun and since it was skill based, I liked working towards getting better.
Philanthropist	“I tried to shoot bottles I threw into the air, like in [the] movies”

Figure 67 Player Types with Quotes from Prototype Two

7.9.3 Discussion

7.9.3.1 Player Types on Mechanics in Prototype One

Before delving into a detailed breakdown and evaluation of the potential effect of player types, let us first examine the quotes and identify any shared responses.

In prototype one, free spirits were notably vocal about their experiences. For example, regarding the doorbell easter egg—where participants could make it float off the wall into space and play with it— at least two participants expressed similar sentiments of excitement and curiosity. Conversely, another player type, the socialiser, shared similar feelings as free spirits regarding watering the plants.

Moreover, in prototype two, both "player" player types exhibited more excitement than tension, showing a preference for the fun and excitement of using a bow and engaging in skill-based gameplay.

To further understand whether these correlations can lead to potential conclusions and uncover any further connections, I have broken down the responses to each mechanic based on player type. Examining the influence of player types on participant responses to the mechanics in Prototype 1 provided insights into how different player profiles interacted with and perceived the VR experiences. By comparing the average ratings across player types seen in **Figure 68**, I identified patterns and variations in the emotional responses elicited by each mechanic.

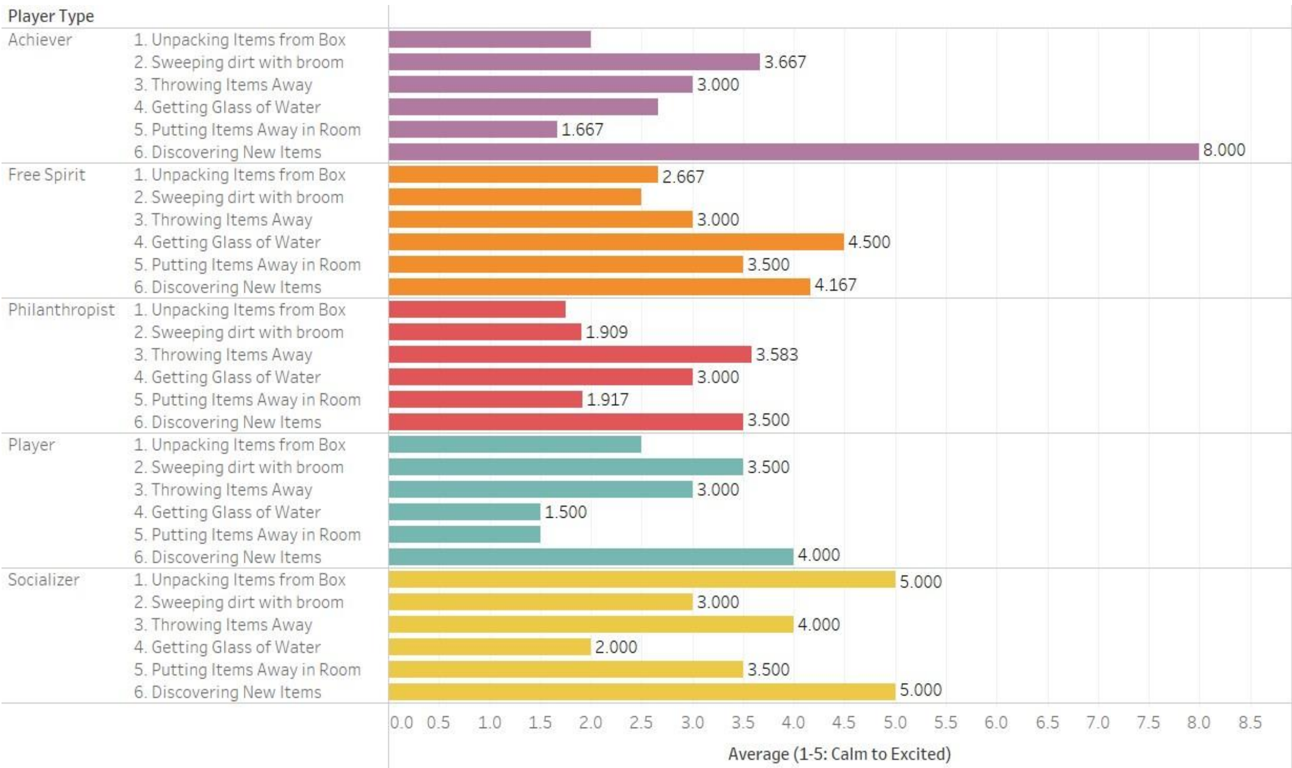


Figure 68 Player Types with Average Emotional Responses

Figure 69 showcases the player types with median emotional responses, which share very similar results.

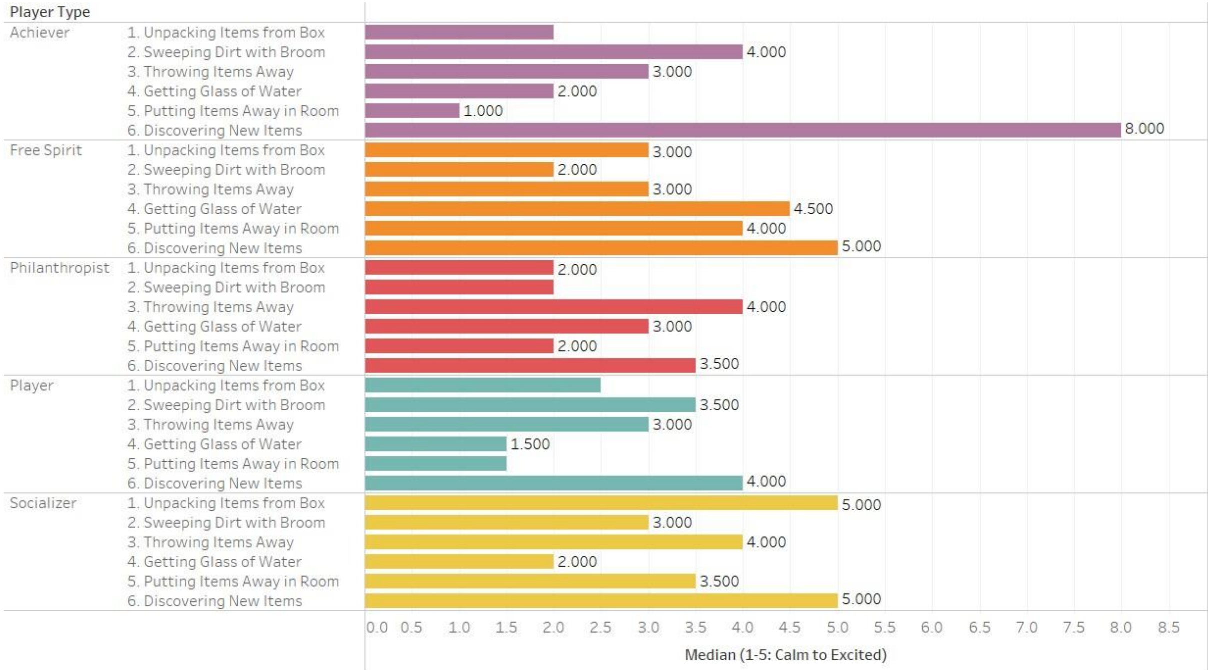


Figure 69 Player Types with Median Emotional Responses

The achiever player type showed a particular affinity for the mechanics of discovering new items and sweeping dirt with a broom, expressing higher levels of enjoyment and engagement. This suggests that these mechanics resonated well with achievers, who may have been motivated by the sense of accomplishment associated with exploring new items and completing tasks such as sweeping.

Free spirits displayed relatively equal responses across all mechanics, with a slight inclination towards favouring discovering new items and obtaining a glass of water. This indicates that free spirits found enjoyment and interest in the novelty and interactive nature of these mechanics, aligning with their preference for unstructured and exploratory experiences.

Philanthropists demonstrated a strong preference for the mechanic of throwing items away, which generated the highest average response among all player types. They also expressed relatively high levels of enjoyment for discovering new items and obtaining a glass of water. This suggests that philanthropists were more drawn to mechanics that involved tidying and organising, aligning with their preference for creating order and harmony.

Overall, philanthropists and players exhibited the lowest average responses across all mechanics. These player types generally had a less enthusiastic reaction to the mechanics compared to other player profiles. However, it is important to note that individual preferences and experiences within player types can still vary.

Players, on the other hand, displayed a liking for discovering new items and sweeping dirt with a broom. These mechanics seemed to resonate well with players, possibly due to the element of novelty and the opportunity for active engagement. In contrast, players showed lower average responses for obtaining a glass of water and putting items away.

Socializers, overall, exhibited higher average responses across all mechanics, with the highest being for unpacking items and discovering new items. This suggests that socializers found enjoyment and engagement in the mechanics that involved interacting with and exploring the virtual environment.

Moreover, it was evident that both free spirits and socializers demonstrated a particular fondness for the task of putting items away, when compared to other player types. While the exact reasons for their preference may vary, one possible explanation could be the sense of creative freedom and customization that accompanies arranging items in the virtual environment. For free spirits, this task may offer a canvas for self-expression, enabling them to curate a space that aligns with their individuality and preferences. Similarly, socializers may find joy in the act of arranging items as it allows them to create an environment that fosters social interactions and engagement with virtual characters.

Overall, when considering the medians, there were no significant changes in the player type influence on mechanics responses. The overall patterns and preferences observed in the average ratings remained relatively consistent.

These findings highlight the influence of player types on the emotional responses evoked by the mechanics in Prototype 1. Understanding how different player profiles engage with and perceive the VR experiences can inform the development of tailored mechanics that cater to specific preferences and motivations. It is important to consider the interplay between mechanics and player types to create a more personalised and immersive emotional experience in VR.

7.9.3.2 Player Types on Quadrant Responses in Prototype One

Examining the influence of player types on quad responses throughout the play session in Prototype 1 provides insights into how different player profiles experienced and expressed emotions. By analysing the distribution of player types across the quads at the start, middle, and end, I can identify potential patterns and variations in emotional experiences.

			Player Type		
Start	Achiever	Free Spirit	Philanthropist	Player	Socializer
1	1	3	6		1
2			1		
3			1		
4	2	3	4	2	1

			Player Type		
Middle	Achiever	Free Spirit	Philanthropist	Player	Socializer
1	2	5	7		1
2		1	1		
3			1		
4	1		3	2	1

			Player Type		
End	Achiever	Free Spirit	Philanthropist	Player	Socializer
1		1	4	1	
2	1		1		
3		1			1
4	1	4	5	1	

Figure 70 Emotional Responses Mapped to Player Types in Prototype One

To understand the effect of player types on this emotional evaluation of participants, **Figure 70** breaks down each of these sections, with the darker colours being the higher concentration of participants.

Across all player types, the distribution of participants in quad 2 (tense or frustrated) and quad 3 (bored) was relatively evenly dispersed at the start, middle, and end of the play session. This suggests that the initial emotional states and subsequent shifts in arousal and engagement were consistent across the various player profiles.

However, it is worth noting that philanthropists showed a relatively higher presence in quad 2 (tense or frustrated) and quad 3 (bored) at the start and middle stages of the play session. This indicates that philanthropists may have initially experienced slightly higher levels of tension or frustration and a greater tendency towards boredom compared to other player types. The reasons for this pattern among philanthropists could be related to their preference for order, organisation, and potential discrepancies in the mechanics' alignment with these preferences. It may be beneficial to further explore the underlying factors contributing to these specific emotional experiences for philanthropists. It is also difficult to conclude this as concrete evidence for the reaction of all philanthropist player types, as the majority of participants in this study proved to be this player type.

These findings suggest that while the distribution of player types across the quads remained relatively consistent, philanthropists displayed a distinctive trend with a higher presence in quad 2 and quad 3 at the start and middle of the play session. This highlights the potential influence of player types on initial emotional states and responses to the VR experience; however, the majority of participants were philanthropists, resulting in unreliability with this conclusion, and requiring further investigation.

7.9.3.3 Player Types on Mechanics in Prototype Two

The analysis of player types' influence on the responses to Prototype 2 mechanics provides insights into how different player profiles experienced and engaged with the VR experience designed to evoke tense emotions. By examining the distribution of player types and their associated responses, I can identify patterns and variations in emotional experiences.

Overall, the distribution of player types across the mechanics in Prototype 2 appeared to be relatively even. This suggests that participants from various player profiles engaged with and experienced the mechanics in a balanced manner, without any particular player type dominating the responses. The average responses can be found in **Figure 71**.

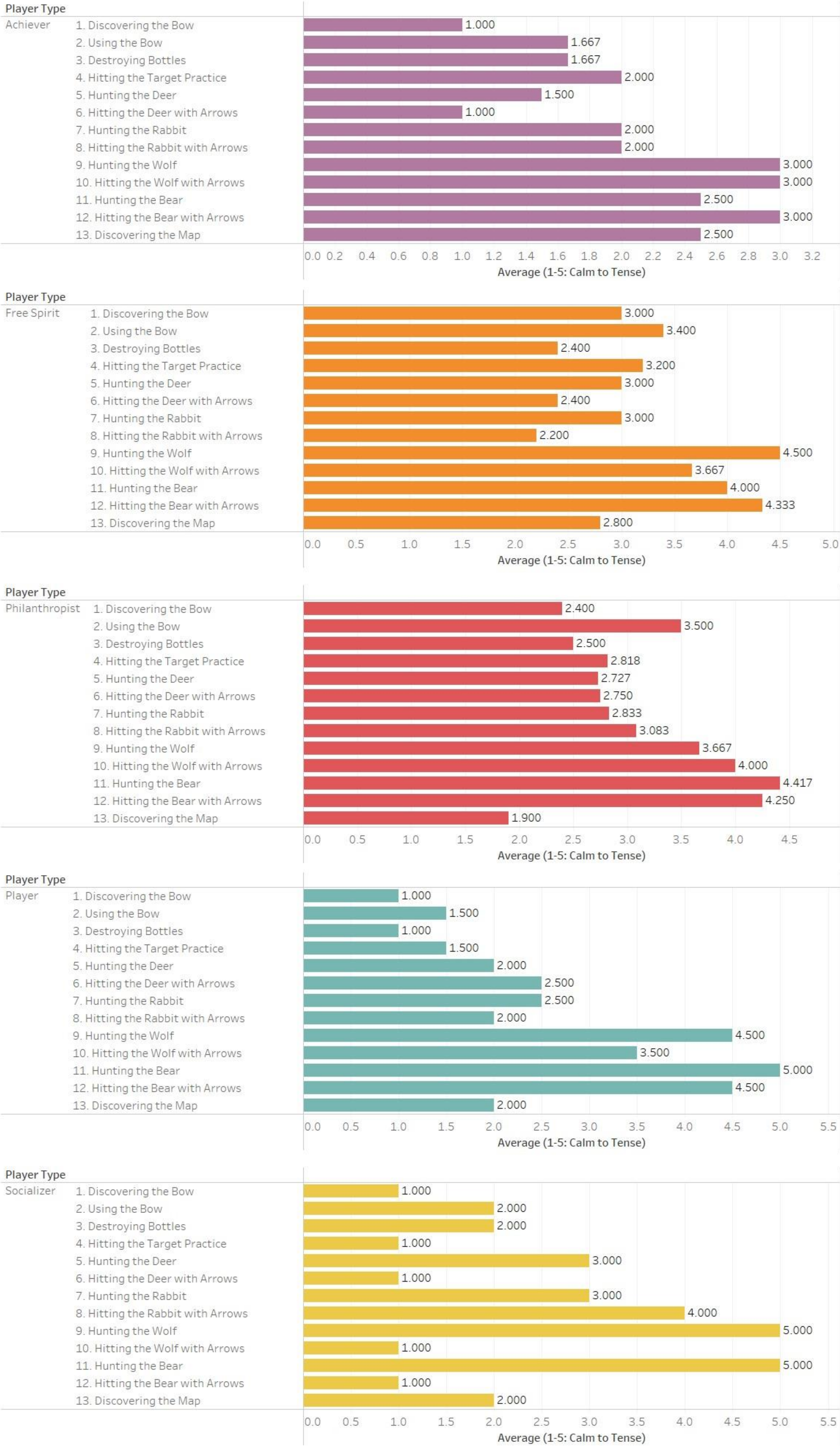


Figure 71 Average Responses of Player Types to Each Mechanic in Prototype Two

However, it is worth noting that players, on average, tended to have lower responses compared to other player types across the mechanics. This suggests that players, who primarily seek enjoyment and entertainment in games, may have had slightly lower levels of engagement or emotional intensity when experiencing the tense mechanics of Prototype 2. Further investigation into the specific preferences and reactions of players within the tense VR context could provide deeper insights into their unique experiences.

In contrast, socializers displayed a higher frequency of positive responses, particularly in relation to the hunting mechanics. This suggests that socializers found greater enjoyment and engagement when engaging in the hunting mechanics, perhaps triggered by the interactive nature of having only auditory cues to direct players to their next hunting objectives and congratulate them on their previous successful hunt. It is plausible that social element the auditory signifiers within the VR environment resonated well with socializers, fostering a heightened sense of enjoyment and engagement. The median responses can be found in **Figure 72** for comparison but showcase the same results as the analysis of averages.

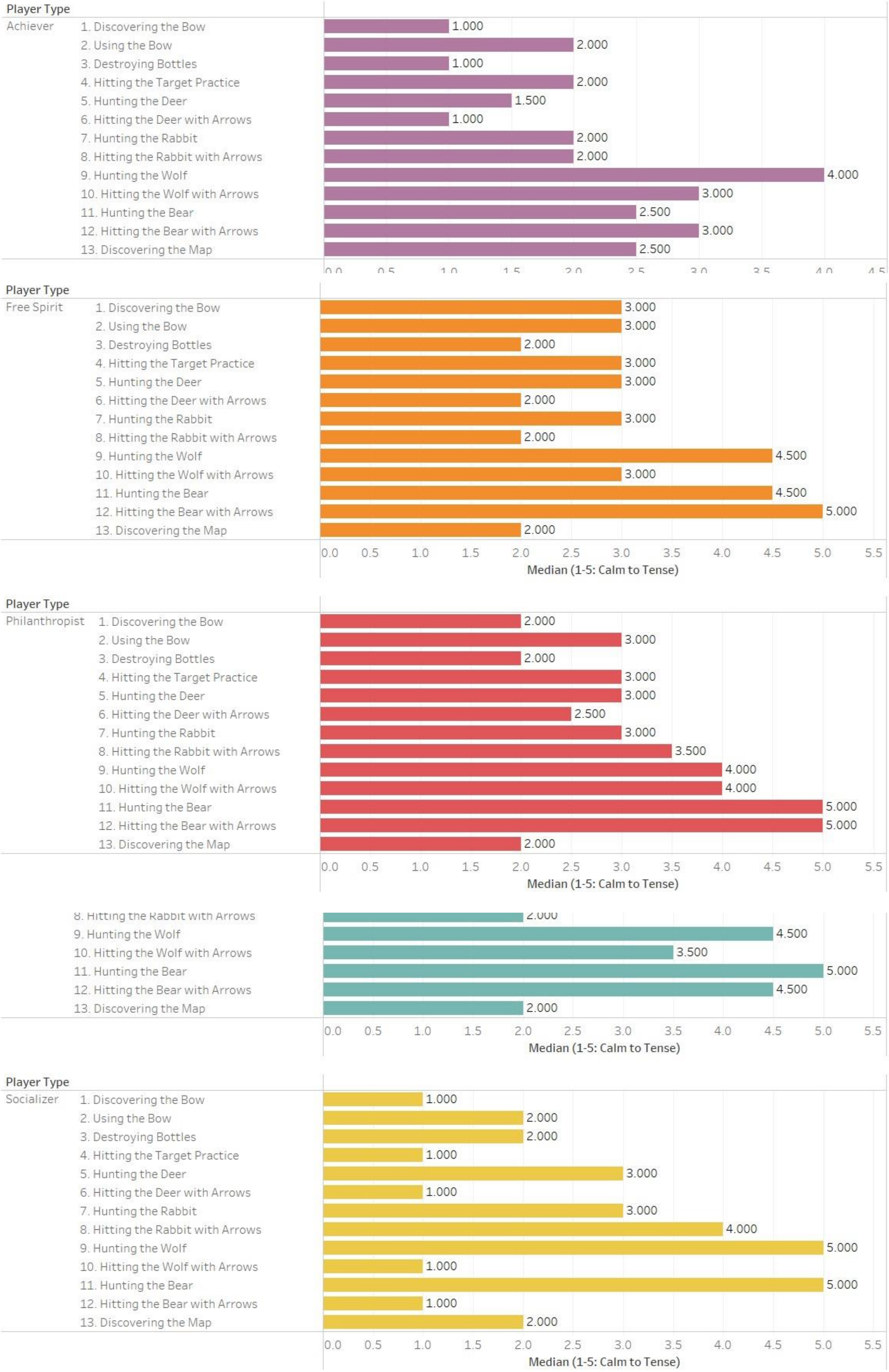


Figure 72 Median Responses of Player Types to Each Mechanic in Prototype Two

In summary, the analysis of player types' influence on Prototype 2 mechanics reveals a relatively even distribution across player profiles. Players, on average, exhibited slightly lower responses compared to other player types, while socializers displayed a higher frequency of positive responses, particularly in relation to the hunting mechanics. These insights provide considerations for future iterations of the framework, ensuring that mechanics align with the preferences and emotional experiences of different player types within the tense VR context.

7.9.3.4 Player Types on Quadrant Responses in Prototype Two

Player types were evenly distributed across the initial and middle phases of the game. The results can be seen in **Figure 73**. However, as the gameplay progressed to the more intense ending of hunting wolves and bears, player types appeared to converge towards a shared emotional response. This convergence suggests that the heightened tension and challenges of the later stages of the game might have overridden initial individual predispositions, leading to a unified emotional experience. This outcome underscores how specific gameplay elements can supersede player tendencies and induce collective emotional engagement, even among diverse player types.

	Player Type				
Start	Achiever	Free Spirit	Philanthropist	Player	Socializer
1	1	5	8		2
2			1		
4	2	1	3	2	

	Player Type				
Middle	Achiever	Free Spirit	Philanthropist	Player	Socializer
1	2	2	8	2	
2		2	1		
3		1	1		
4	1	1	1		1

	Player Type				
End	Achiever	Free Spirit	Philanthropist	Player	Socializer
1	1	1	6		
2	1	2	3	2	1

Figure 73 Player Types Mapped to Emotional Responses in Prototype Two

Furthermore, **Figure 74** illustrates the distribution of player types and how their preferences for movement were divided.

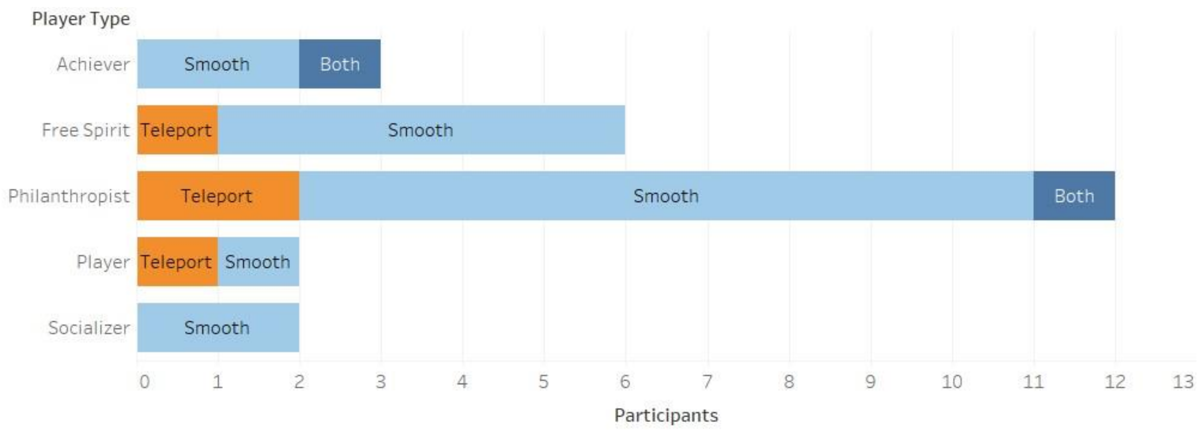


Figure 74 VR Locomotion Preferences by Player Type

7.9.3.5 Framework Integration and Reflection

Initially, the notion of incorporating player types as a design consideration emerged as a means to address the subjective realm of VR by identifying distinct user response categories and subsequently adapting mechanics accordingly. This was exemplified by creating my secondary research question. However, the endeavour encountered a roadblock due to insufficient data stemming from player types.

Upon attempting to integrate this concept into the broader framework, reminiscent of the initial model ideas outlined in Chapter 4, complexities emerged that weren't initially apparent. The realization dawned that player types are highly intricate and multifaceted entities. Each player type, regardless of the framework employed, harbours a multitude of intricate considerations that extend far beyond mere categorization.

To meaningfully incorporate player types into the framework, comprehensive research solely focused on this aspect would be imperative. While the studies I conducted provided a fertile ground for gathering initial data on the potential impacts of different player types and extrapolating initial implications, the data volume wasn't substantial enough for robust testing, especially given the prevalence of a predominant player type that could not render the findings conclusive.

Considering the current juncture, where a seamless integration into the framework remains elusive, it would be premature to offer precise design insights to developers based on the existing knowledge. Therefore, I decided to not go forward with player type considerations for this framework.

Chapter 8: Conclusion

8.1 Introduction

This thesis has delved into the construction of a framework for designing VR mechanics that elicit targeted emotions. In pursuit of this objective, existing VR games underwent personal playtesting, followed by the validation of results via a pilot study. Subsequently, the developed framework was implemented in the creation of two distinct VR prototypes. These prototypes were then assessed by participants, whose feedback substantiated the framework's efficacy. This iterative process illuminated the identification of emotions elicited by various mechanics and showcased the spectrum of their performance. **Appendix D** contains a detailed overview of the framework that was developed based on the revisions derived from the studies, while **Appendix E** applies the framework as design patterns. Furthermore, the research delved into player typologies, enhancing the comprehension of emotional variations essential for embedding in the design framework.

8.2 Research Summary

The intersection of emotional design and virtual reality (VR) games constitutes an innovative domain with implications for user engagement, psychological resonance, and the broader landscape of game design. While the significance of innovation and technological advancement is undeniable in virtual reality, this thesis underscores the primacy of user experience and emotional engagement in VR games and design methodologies.

VR games, as immersive and experiential mediums, are uniquely poised to tap into users' emotional responses and elicit heightened emotions in users when compared to traditional gaming mediums. The framework proposed in this thesis positions emotions as the focus, presenting a structured method to design VR mechanics that elicit targeted emotions. Although the two prototypes of this thesis' practical application concentrate on two specific emotions, the study's success and the framework's design suggest its applicability to a wide array of emotions.

Recognizing the influence of emotions on user engagement and experience, this research employs a comprehensive approach. The blend of self-report questionnaires, physiological measures, and behavioural observations delves into the intricate dynamics of emotional responses within VR environments. This methodology aligns with the principle that the essence of successful design is to comprehend human needs and translate this understanding into tangible experiences.

Furthermore, emotional design in VR games enhances users' engagement through its immersive nature heightening emotional responses. By crafting experiences that resonate emotionally, VR game developers contribute to heightened immersion, reduced cognitive dissonance, and ultimately, greater player satisfaction.

8.3 Contributions of the Research

This research has delivered several significant contributions to the field, spanning the domains of emotional design, psychology, methodology, and VR/games design.

8.3.1 Contributions to Theory

In the realm of psychology, this research contributes to our understanding of emotions and their elicitation in VR environments. By conducting a comprehensive pilot study, I gained insights into the alignment between participants' emotional responses and the initial conceptual framework. This enhances existing theories on emotional design, providing empirical evidence to support the effectiveness of VR mechanics in evoking targeted emotions. Moreover, my investigation into player types and their relationship with emotional responses enriches the understanding of individual differences in emotional experiences, contributing to the broader domain of psychological research on emotions.

In the field of emotional design, this research has introduced a novel framework for VR mechanics that effectively elicit specific emotional states. By developing two distinct VR prototypes focused on calming and tense emotions, I demonstrated the applicability of this framework in designing emotionally engaging VR experiences. This contribution extends the literature on emotional design, providing designers and developers with insights on creating immersive and emotionally impactful VR content.

Additionally, within VR/games design, this research adds to the growing body of knowledge on the emotional potential of virtual reality experiences. By exploring the effectiveness of the developed VR mechanics, this thesis expands the understanding of how emotions can be leveraged to enhance player engagement and immersion in VR games. This research aids game developers in crafting emotionally resonant experiences that cater to a diverse range of player preferences.

8.3.2 Contributions to Methodology

This research makes contributions to methodology by employing a research by design approach, ensuring the design of the framework was tested and refined to present a working solution at the end of this thesis.

Additionally, recognizing the multi-dimensional nature of emotions, I designed a comprehensive strategy that amalgamates self-report questionnaires, interviews, physiological measures mapped to the circumplex model of affect, and behavioural observations. This methodological integration was pivotal in capturing the intricate and varied emotional responses of the participants, while ensuring the validity and reliability of the emotional evaluations, thereby facilitating a holistic examination of participants' emotional experiences.

8.3.3 Contributions to Practice

Lastly, this research's ultimate contribution lies in the marriage of theoretical frameworks with practical applications. The developed emotional design framework offers a supportive tool to designers, aiding them in creating emotionally charged VR experiences. By offering a systematic approach to eliciting specific emotions, this tool can be applied to various domains, including entertainment, education, training, and therapeutic applications. Furthermore, the framework is designed to be flexible, allowing for customization and tailoring to suit specific project requirements. This adaptability empowers industry professionals to apply the framework across various contexts, thereby unlocking the potential for purposeful emotional design in a broad spectrum of VR applications.

Moreover, the framework serves as a foundation for further development and refinement. As new research and technological advancements emerge, the framework can be updated and expanded to accommodate evolving insights and opportunities. By encouraging iterative development, this research stimulates ongoing innovation in emotional design and VR/games experiences.

8.4 Research Limitations

Despite the significant contributions, this research is not without limitations. Emotions are inherently subjective and can vary based on individual differences and contextual factors. While efforts were made to account for this subjectivity, and player types were chosen as a measure to explore potential controls for these emotional variations, it is essential to acknowledge the potential impact of emotional subjectivity on the findings.

Another limitation lies in the scale of the VR prototypes used in the main study. While effective in evaluating the framework's initial performance, the limited scale of the prototypes may have constrained the full range of emotional experiences that could be elicited. Future research could explore a more extensive variety of VR mechanics to enrich the framework and broaden its emotional impact.

Additionally, the emotions addressed in the design of the VR prototypes might not fully capture the entire emotional spectrum. While the focus on calming and tense emotions was deliberate, other emotions could be incorporated to create a more comprehensive emotional experience in future iterations.

Moreover, the volume of mechanics included in the framework may also present limitations in its application. While I endeavoured to create a diverse set of mechanics, the framework may benefit from further expansion to encompass an even broader range of emotional possibilities.

Lastly, the number of VR games I evaluated in this research was limited, given the time and resource constraints. While the prototypes developed for the main study showcased the framework's initial potential, a larger pool of VR games could provide a more robust assessment of its adaptability and effectiveness across different contexts.

8.5 Suggestions for Further Research

Building on the research findings, this study lays the groundwork for several potential avenues of future exploration in the realms of emotional design, VR/games design, and psychology. Building upon the insights gained from the pilot study and the playtesting of Prototype 1 and Prototype 2, there are several key areas that warrant further investigation and development. These future research directions aim to deepen our understanding of emotional design in VR and optimize the framework for enhanced user experiences.

1) **Expansion of Participant Pool:** To strengthen the generalizability of the framework's findings, future research should involve a larger and more diverse participant pool. Including participants with varying backgrounds, demographics, and levels of VR familiarity can provide a broader perspective on emotional experiences in VR. This expansion can also help identify potential individual differences and preferences that may influence emotional responses.
2) **Long-Term Emotional Effects:** Examining the long-term emotional effects of VR experiences is an important area for future exploration. While the pilot study and playtesting provided insights into immediate emotional responses, understanding the lasting impact of these experiences can contribute to the development of emotionally

engaging and sustainable VR content. Longitudinal studies can investigate how emotional responses evolve over time and whether they have any influence on subsequent interactions with VR.

3) **Refinement of Mapping Process:** Further refinement of the mapping process between inputs and emotional responses within the circumplex model of affect is essential. Investigating the nuanced relationships between specific mechanics, player interactions, and emotional outcomes can help refine the mapping guidelines. Additionally, exploring the potential integration of other affective models or considering individual differences in emotional perception can enhance the precision and accuracy of emotional design in VR.
4) **Personalization and Adaptive Systems:** Expanding the framework to incorporate adaptive systems and personalised experiences is a promising direction for future research. By leveraging player profiling techniques, such as psychometric assessments or real-time monitoring of physiological responses, developers can dynamically adapt VR experiences to individual emotional preferences and needs. This personalization can lead to more immersive and emotionally resonant experiences, maximising user engagement and satisfaction.
5) **Cross-Cultural and Cross-Domain Studies:** Conducting cross-cultural studies and exploring the application of the framework in different domains can provide beneficial insights into the universality and versatility of emotional design in VR. Comparing emotional responses across cultures and examining the impact of cultural factors on emotional experiences can inform the development of culturally inclusive and emotionally engaging VR content. Furthermore, exploring the application of the framework beyond gaming, such as in educational or therapeutic contexts, can unlock new possibilities for utilising VR to evoke targeted emotions.
6) **Quantitative Outcomes and Cognitive Experiments:** The prospect of integrating a quantitative survey alongside cognitive behavior experiments holds promise for gathering supplementary data. This approach could unveil more direct correlations between participants' brain responses and emotions, complementing the qualitative insights gained from the study.
7) **Player Types**: The concept and possibilities of incorporating player types into the framework would offer the potential ability to address variations in emotional responses from the players. Due to the complexity of player types and the depth of

research required, this framework did not end up adding it in directly. However, there is research and analysis of player types provided in this thesis that can serve as initial support for future endeavours into this area.

By focusing on these future research directions, researchers and designers can continue to refine and expand the framework, pushing the boundaries of emotional design in VR. These endeavours will contribute to the advancement of immersive and emotionally engaging virtual experiences, facilitating deeper connections between users and the virtual worlds they inhabit.

8.6 Conclusion and Final Remarks

The framework for VR mechanics that elicit targeted emotions, developed and tested through the pilot study and playtesting of Prototype 1 and Prototype 2, represents a significant contribution to the field of emotional design in virtual reality. By mapping inputs derived from playtesting VR games to potential emotional responses using the circumplex model of affect, the framework has successfully guided the design and implementation of mechanics that evoke two specific emotional states. The analysis of participant feedback, quad responses, and player type influence has provided valuable insights into the effectiveness of the framework and its potential for creating immersive and emotionally resonant VR experiences.

The findings of this thesis demonstrate that the framework has the potential to enhance the emotional engagement and user experience in virtual reality. By aligning mechanics with specific emotional outcomes and considering individual player types, developers can create personalised and captivating VR experiences that cater to a range of emotional preferences. The successful implementation of the framework in Prototype 1 and Prototype 2 reinforces its efficacy in evoking targeted emotions and guiding emotional trajectories within the virtual environment.

However, it is essential to acknowledge that emotional design in VR is a complex and evolving field, and there are still challenges and opportunities for further exploration. Future research should focus on expanding the framework's reach through larger and more diverse participant samples, investigating long-term emotional effects, refining the mapping process, incorporating personalised and adaptive systems, and exploring cross-cultural and cross-domain applications.

Moreover, as VR technology continues to advance and new possibilities emerge, it is crucial to adapt and refine the framework accordingly. By keeping pace with technological developments and embracing interdisciplinary collaborations, researchers and designers can push the boundaries of emotional design in VR, creating innovative and transformative experiences.

Concluding this thesis with a comprehensive understanding of the framework's performance, future research directions, and final remarks, I have provided a solid foundation for continued exploration and advancement in emotional design for virtual reality games and experiences.

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Appendix A: VR Games Play-tested per Genre

Game Title	Year	Publisher	Steam Ratings (0-100%)	Number of Reviews
Action				
Half-Life: Alyx	2020	Valve	98%	71,098
Blade and Sorcery	2018	WarpFrog	96%	41,144
Pavlov VR	2017	Vankrupt Games	93%	34,576
Boneworks	2019	Stress Level Zero	92%	31,844
Gorn	2019	Devolver Digital	94%	7,172
Sairento VR	2018	Mixed Realms Pte Ltd	87%	1,405
Sports				
Gorilla Tag	2023	Another Axiom	93%	6,187
The Thrill of the Fight	2016	Sealost Interactive LLC	95%	3,437
Eleven: Table Tennis VR	2016	For Fun Labs	95%	2,815
Walkabout Mini Golf	2021	Mighty Coconut	98%	2,217
Creed: Rise to Glory	2018	Survios	80%	1,341
Simulation				
Hot Dogs, Horseshoes & Hand Grenades	2016	RUST LTD.	97%	17, 652
VTOL VR	2017	Boundless Dynamics, LLC	98%	11,649
Fallout 4 VR	2017	Bethesda Softworks	64%	4,573
Job Simulator	2016	Owlchemy Labs	91%	3,215
Cooking Simulator VR	2023	Big Cheese Studio, PlayWay S.A.	85%	1,090
Adventure				

The Elder Scrolls V: Skyrim VR	2018	Bethesda Softworks	74%	7239
Moss	2018	Polyarc	94%	2,384
Vertigo 2	2023	Zulubo Productions	96%	1,333
The Gallery - Episode 1: Call of the Starseed	2016	Cloudhead Games ltd.	81%	1,011
A Fisherman's Tale	2019	Vertigo Games	93%	833
Rhythm				
Beat Saber	2019	Beat Games	95%	63,481
Superhot VR	2017	SUPERHOT Team	83%	6,460
Pistol Whip	2019	Cloudhead Games ltd.	93%	3,182
Audioshield	2016	Dylan Fitterer	80%	2,634
Ragnarock	2021	WanadevStudio	95%	2,320
Horror				
Into the Radius VR	2020	CM Games	94%	7,291
Arizona Sunshine	2016	Vertigo Games	80%	6,871
The Walking Dead: Saints & Sinners	2020	Skydance Interactive	88%	6,566
Propagation VR	2020	WanadevStudio	94%	4,797
The Room VR: A Dark Matter	2020	Fireproof Games	97%	3,047
Strategy				
I Expect You To Die	2017	Schell Games	95%	1,838
I Expect You To Die 2: The Spy and the Liar	2021	Schell Games	96%	946
In Death	2018	Sólfar Studios	84%	887
BattleGroupVR	2023	SpaceOwl Games, Erabit	93%	724
The Talos Principle VR	2017	Devolver Digital, Croteam Publishing	83%	719

Appendix B – Game Mechanics and Examples

Physics – Realistic

Implementing realistic physics in VR games can greatly enhance immersion and player engagement. By replicating real-world behaviours, such as weight, collisions, and object interactions, players feel more connected to the virtual environment. Developers should focus on maintaining consistency in physics interactions to ensure a seamless experience, not just in their core gameplay of weapons, but also in the more minute instances.

Game	Example Mechanics and Interactions	Potential Emotions Elicited
In Death: Unchained	Archery mechanics requiring precision and aiming. Shooting with realism and accuracy in a bow and arrow VR game.	Anticipation (archery aiming), Tension (precise aiming), Frustration (missing shots), Satisfaction (hitting shots)
The Elder Scrolls V: Skyrim VR	Realistic bow mechanics involving notch, draw, and vibrate when firing. Detailed aiming system.	Anticipation (notching arrow), Excitement (shooting action), Frustration (missing shots), Satisfaction (hitting shots)
Fallout 4 VR	Realistic throwing mechanics for grenades. Engaging with lifelike throwing and projectile mechanics.	Anticipation (throwing action), Excitement (explosion), Frustration (missing throw), Satisfaction (landing throw)
Walkabout Mini Golf	Physics-based golf mechanics with realistic tension and putting.	Enjoyment (successful shots), Frustration (missed shots), Satisfaction (swinging putt)
Boneworks	Realistic weapon handling based on weight and physics. Interactive and immersive combat with varying weapon weights.	Fear (enemy encounter), Aggression (weapon swinging), Enjoyment (successful aiming), Frustration (missing shots)
Blade and Sorcery	Detailed weapon handling and physics-based combat. Realistic sword and weapon mechanics.	Aggression (weapon strikes), Excitement (satisfying hits/hitting weak points), Fear (Close combat fighting), Satisfaction (Landing hits),
Half-Life Alyx	Detailed throwing and aiming mechanics. Interacting with throwable objects and aiming for precise hits. Realistic object physics interactions. Engaging with lifelike object handling and placement – *e.g.* crushing a can and putting in bin	Anticipation (precise throws/shots), Excitement (accurate hits), Enjoyment (successful interactions), Curiosity (experimentation), Joy (discovering new interaction),

Physics – Whacky Embracing exaggerated physics interactions in VR games can offer a unique and entertaining experience. Players enjoy the freedom to experiment with unconventional mechanics, creating a sense of playfulness. Developers should balance fun with usability, ensuring that whacky physics interactions remain engaging and enjoyable without becoming frustrating.		
Game	Example Mechanics and Interactions	Potential Emotions Elicited
Superhot VR	Enemies break like glass when hit. Throwing objects to defeat opponents.	Surprise (breaking enemies), Excitement (defeat)
Vertigo 2	Different physics for various weapons. - Engaging with unpredictable weapon behaviours.	Surprise (unpredictable physics)
Gorn	Physics-based melee combat with exaggerated animations. Engaging in humorous and exaggerated combat interactions.	Excitement (engaging combat), Amusement (humour)
Job Simulator	Interacting with exaggerated physics in various job scenarios. Experiencing humorous and unrealistic job-related interactions.	Amusement (job interactions), Enjoyment (play)
I Expect You To Die	Engaging with humorous and exaggerated object physics in espionage-themed scenarios. Experiencing comical and entertaining interactions.	Amusement (physics interactions), Enjoyment (play)

Combat – Reloading Realistic reloading mechanics in VR combat games add authenticity to the experience. Players find satisfaction in performing actions like chambering rounds and swapping magazines. Developers should prioritize intuitive controls that mirror real-world reloading processes, enhancing immersion and tactical gameplay.		
Game	Example Mechanics and Interactions	Potential Emotions Elicited
The Walking Dead: Saints & Sinners	Realistic reloading mechanics with magazine insertion and chambering. Engaging with lifelike weapon reloading interactions.	Fear (reloading under threat), Frustration (jamming)
Arizona Sunshine	Unconventional reloading mechanics involving motion controller buttons and torso tapping. Experiencing unique reloading interactions.	Surprise (unconventional reloading), Enjoyment (interaction)
Half-Life: Alyx	Realistic reloading involving ejecting and chambering magazines. Engaging with lifelike weapon reloading processes.	Anticipation (ejecting magazine), Excitement (chambering)
Vertigo 2	Different reload speeds based on weapon impact. Encouraging weapon variety and strategic reloading.	Anticipation (strategic reloading), Excitement (changing weapons)

Combat – Weak Points / Mastery System: Incorporating weak points and mastery systems in combat mechanics adds depth and strategy to gameplay. Players feel a sense of accomplishment when targeting specific enemy vulnerabilities. Developers should design clear visual cues for weak points and ensure that mastering these mechanics provides tangible rewards and benefits.		
Game	Example Mechanics and Interactions	Potential Emotions Elicited
Vertigo 2	Creative and varied enemy types with unique strategic challenges. Engaging with the thrill of discovering and exploiting enemy weaknesses for tactical advantage.	Anticipation (strategic challenges), Excitement (variety)
The Thrill of the Fight	Striking weak points on the Training Dummy for quick knockouts. Experiencing the satisfaction of mastering weak points for efficient combat.	Excitement (knockouts), Mastery (weak point mastery)
Blade and Sorcery	Prioritizing head, neck, legs, and weapon arm as weak points. Using skilful movement and combination attacks to exploit enemy vulnerabilities.	Mastery (strategic combat), Anticipation (opening enemy)

Combat – Death System Implementing a death system that encourages quick learning and experimentation creates a balance between challenge and fun. By providing players with opportunities to adapt and strategize after each death, developers can maintain engagement and mitigate frustration.		
Game	Example Mechanics and Interactions	Potential Emotions Elicited
Walking Dead: Saints & Sinners	Upon death, losing all loot and respawning outside the area. Feeling cautious about potential losses.	Fear (potential loss), Caution, Frustration, Satisfaction (Successful recovery)
Gorn	Imaginary timer starts upon hit, screen going black. Experiencing urgency to secure a kill and continue.	Fear (potential defeat), Urgency, Panic, Tension

Movement – Climbing Creating intuitive climbing mechanics allows players to explore vertical environments seamlessly. Developers should prioritize smooth and responsive controls, enabling players to traverse surfaces naturally. Providing visual and haptic feedback enhances the climbing experience.		
Game	Example Mechanics and Interactions	Potential Emotions Elicited
Gorilla Tag	All sorts of climbing – ex: pinch climbing for scaling objects. Wall jumping to move between two walls. Branching, jumping between tree branches. Wall climbing and wall running. Free-running for unpredictability.	Excitement (quick movement), Strategy (routes), Mastery (complex techniques)
Blade and Sorcery	Climbing buildings and walls for height advantage. Escaping enemies by climbing.- Using scenery to prevent enemies from getting close.	Tension (escaping enemies), Strategy (obstruction usage)
Boneworks	Detailed physics interactions for climbing and traversing. Climbing walls to gain height and escape enemies.	Excitement (physical interaction), Tension (escaping), Curiosity (physics exploration)
Half-Life: Alyx	Climbing ladders and ropes for vertical movement. Climbing obstacles and structures to access new areas. Traversing environments for exploration.	Curiosity (exploration), Mastery (efficient traversal)
The Climb	Dedicated climbing game with natural movement mechanics. Climbing various surfaces and terrains. Immersion in a realistic climbing experience.	Excitement (height challenge), Mastery

		(climbing skills), Wonder (realistic immersion)

Movement – Time Pause/Stop

Time manipulation mechanics in VR games offer exciting opportunities for strategic thinking and action. Developers should design these mechanics to align with player expectations, ensuring that pausing time and planning actions feel intuitive and responsive.

Game	Example Mechanics and Interactions	Potential Emotions Elicited
Superhot VR	Time is at a standstill until the player moves, then everything speeds up. Thrilling take on classic bullet time mechanic.	Excitement (control over environment), Tension/Fear (when moving too fast), Joy (moving slow/watching level unfold)
Fallout 4 VR	VATS system allows player to slow down time and select body parts to aim.	Excitement (aiming), Curiosity (exploring its applications to different aiming possibilities), Tension (lining up aim on tougher targets)
Creed: Rise to Glory	Game enters slow-motion mode after successful dodging, allowing counterpunching and strategic moves. Enhances engagement in combat.	Excitement (successful activation), Joy (Mastery involved), Tension (small amount in some players – thinking of next move when triggered)
Sairento VR	Overdrive mechanic enables short bursts of bullet time via Grip button. Useful for precise aiming, dodging bullets, and mid-air actions.	Excitement (successful activation), Frustration (mastery level is difficult), Satisfaction (when mastery level rises)

Movement – Dodging System

Incorporating a dodging system in VR games adds dynamic and immersive combat mechanics. Players enjoy physically evading attacks, enhancing engagement. Developers should ensure that the dodging system is responsive and there are enough opportunities in the environment to do so.

Game	Example Mechanics and Interactions	Emotions Elicited
Blade and Sorcery	Dodging to avoid attacks from enemies. Utilizing movement and misdirection to evade opponent attacks. Incorporating dodges to create openings for counterattacks.	Fear (avoiding attacks), Anticipation (strategic planning), Joy (avoiding danger)

Half-Life: Alyx	Dodging behind obstacles, walls, or barriers to reload and regroup during combat. Evading enemy attacks and taking cover using physical movement.	Fear (avoiding enemy attacks), Anticipation (planning movements), Relief (finding cover)
Walking Dead: Saints & Sinners	Utilizing dodging as a defensive manoeuvre against zombie attacks. Physical dodging to avoid being grabbed or bitten by enemies.	Fear (escaping danger), Surprise (reacting quickly), Tension (physical exertion)

Movement – Teleportation Teleportation mechanics offer a unique approach to movement in VR. While there is the traditional mode of teleportation, other games seek to press the boundaries of movement. Additionally, teleportation has proved helpful for motion sickness, so further exploration into this area could prove promising.		
Game	Example Mechanics and Interactions	Potential Emotions Elicited
In Death	Teleportation via 'shard' or teleportation arrow. Smooth forward locomotion and snap-turn settings. Variable control options for different setups.	Joy (Freedom), Anticipation (aiming correctly), Trust (reliable system), Excitement (shards fit more into theme of game, less jarring than traditional so offers more excitement)
Sairento VR	Primary use of teleportation for movement. Abilities like double jump, wall run, ground slice, and surface bouncing. Dynamic and agile movement options.	Excitement (anticipation and joy of movement), Trust (reliable system/consistent performance), Frustration (on failure), Joy (discovering new form of movement)

Interactions – Two Hands/Advanced Involvement Mechanics that require the use of both hands offer immersive and engaging interactions. Developers should design these mechanics to feel natural and intuitive, enhancing player involvement and making the most of VR's unique capabilities.		
Game	Example Mechanics and Interactions	Emotions Elicited (Trigger Points)
BattleGroupVR	Navigating a 3D holographic map using hand gestures to control and command ships in a virtual space. Utilizing physical hand movements for ship interactions and map navigation.	Interest (Holographic interaction), Excitement (Control over ships), Joy (Immersive experience)

Ragnarock	Drumming mechanic where accurate timing impacts crew performance and unlocks power-ups. Drumming gestures involving both hands to enhance in-game elements.	Excitement (Perfect timing), Joy (Powerful combos), Engagement (Active physical interaction)
Job Simulator	Using both hands to operate a virtual slushie machine, simulating real-world movements to dispense and create virtual slushies. Immersive and interactive two-handed simulation of a slushie-making process.	Joy (Interactive simulation), Interest (Realistic movement), Amusement (Creating virtual slushies)

Combat – Stamina System/Health System Combining stamina and health systems in VR combat games introduces tactical depth. Players must manage their resources strategically, adding a layer of realism to battles. Developers should ensure that these systems are balanced to prevent excessive frustration and maintain fluid gameplay		
Game	Example Mechanics and Interactions	Potential Emotions Elicited
Creed: Rise to Glory	Stamina system where punches lose impact after quick succession. Blocking and dodging for stamina.	Frustration (diminished impact), Delight/Pleased (successful actions)
The Walking Dead: Saints & Sinners	Eating food or using health items to restore health Regaining health by consuming items.	Relief (health restoration), Gratification (successful healing)
Gorn	Stamina system where attacks are less effective when tired. Strategically managing attacks and recovery.	Frustration (ineffective attacks), Tension and Excitement (Tactical thinking)

Interactions – Hands On/Feedback Providing hands-on interactions and responsive feedback in VR games enhances realism and player agency. Developers should focus on detailed object interactions and haptic feedback to create a tactile and immersive experience.		
Game	Example Mechanics and Interactions	Emotions Elicited
The Talos Principle VR	Solving puzzles involving turret-like nodes, disabling shields, and creating circuits between switches. Physical interactions with puzzle elements, enhancing engagement and problem-solving.	Joy (solving challenges), Curiosity (exploring mechanisms), Anticipation (creating circuits)

I Expect You To Die	Frequent death states designed with care and humour, teaching players through trial and error. Interacting with objects in creative ways, like putting a hat on a bear or lighting a cigar with a burning log.	Amusement (experimenting with interactions), Surprise (unexpected outcomes), Satisfaction (solving puzzles)
The Room VR: A Dark Matter	Executing fine movements like picking a lock, twisting levers, and adding ingredients to a cauldron. Hands-on manipulation of intricate puzzle components to solve mysteries.	Curiosity (exploring intricate mechanisms), Awe (summoning magic), Focus (fine-tuning movements)
Audioshield	Physically hitting notes with shields, including variety in note types and fitness modes. Reacting to different note shapes and patterns, utilizing hand-eye coordination.	Excitement (hitting notes in rhythm), Challenge (reacting to note variety), Satisfaction (accuracy)
Walkabout Mini Golf	Engaging in zany mini-golf courses with various obstacles and designs for each hole. Physical interactions with windmill contraptions and other elements on the course.	Joy (playing realistic mini-golf), Amusement (zany obstacles), Camaraderie (playing with friends)
Eleven: Table Tennis VR	Experiencing force feedback from the controller, making the sensation of hitting the ball with the bat more realistic. Realistic and tactile interactions with the ping pong ball and bat.	Excitement (realistic interactions), Focus (precision in gameplay), Satisfaction (well-executed hits)

Interactions – Diegetic UI/Menus

Diegetic UI and menus maintain immersion by integrating information seamlessly into the game world. Developers should prioritize visual clarity and ease of use to ensure that diegetic elements enhance the player's experience without causing frustration. Also serves as a very creative way to incorporate any information a player may need constant access to.

Game	Example Mechanics and Interactions	Emotions Elicited (Trigger Points)
The Walking Dead: Saints & Sinners	Player's watch alerts them with beeps at intervals, indicating impending walker migrations. Time-sensitive mechanics that encourage players to plan their actions carefully.	Anticipation (Beeps), Fear (Impending threat), Apprehension (Time pressure)

Into the Radius VR	Backpack inventory system simulates a real bag, allowing players to organise items and experience the realism of grabbing items from a cluttered bag.Clipping items and mis-grabs enhance immersion and evoke a sense of panic during intense moments.	Surprise (Unpredictable interactions), Anxiety (Mis-grabs), Panic (Intense situations)
Fallout 4 VR	Use of the Pip-Boy as an inventory system in VR, with players navigating the menu using motion controllers. Realistic interaction with the Pip-Boy on the wrist, enhancing the immersive post-apocalyptic experience.	Anticipation (Exploring inventory), Interest (Interacting with Pip-Boy), Surprise (Novelty)
The Gallery - Episode 1: Call of the Starseed	Intuitive backpack inventory system, allowing players to reach behind and grab the floating backpack to access and manage items. Seamless interaction with the backpack as part of the immersive puzzle-solving experience.	Interest (Interactive inventory), Curiosity (Exploring mechanics), Amusement (Innovative UI)
Walkabout Mini Golf	Diegetic UI elements, like looking at the wristwatch to see Par for the hole and checking the scoreboard for an aerial view of the course. Added realism through diegetic UI components that enhance gameplay immersion.	Interest (Aerial perspective), Joy (Scoring well), Amusement (Unique UI interactions)
Hot Dogs, Horseshoes & Hand Grenades	Button-based weapons spawner system with a tablet for spawning different ammo types and bullet variations. Quick navigation and customization of weapons and ammunition, providing creative gameplay opportunities.	Interest (Customization), Surprise (Variety of ammo types), Excitement (Creative gameplay)
VTOL VR	Realistic room-scale navigation system where players physically move around the cockpit and interact with controls. Immersive piloting experience with hands-on control of the aircraft's components.	Anticipation (Piloting experience), Fear (Realistic controls), Interest (Navigating cockpit)

Appendix C – Assets Used in Prototypes

Asset Name	Description of Use	Link
HVR Framework	Provided framework for physics-based interactions, and base for bow	https://assetstore.unity.com/packages/tools/physics/hurricane-vr-physics-interaction-toolkit-177300
Cardboard Boxes Pack	Used for cardboard boxes to store items	https://assetstore.unity.com/packages/3d/props/cardboard-boxes-pack-30695
Wooden Toys	Puzzles to play	https://assetstore.unity.com/packages/3d/props/wooden-toys-43891
Glass of water GitHub	Used for water physics system to get a cup of water	https://github.com/Macoron/Unity-Simple-Liquid
DoorBell Shortened	Used for doorbell sound when players touch doorbell button	https://freesound.org/people/jwheeler91/sounds/442280/
Low Poly Christmas Pack Free	Props to unpack	https://assetstore.unity.com/packages/3d/props/low-poly-christmas-pack-free-184483
Low Poly Crates	Used as storage crates for plants	https://assetstore.unity.com/packages/3d/props/low-poly-crates-80037
15 low poly models	Used for the broom	https://assetstore.unity.com/packages/3d/props/15-low-poly-models-202061
Free 1980 – MidPoly Retro Rooms	Used for the room base, some shelving, and books	https://assetstore.unity.com/packages/3d/props/interior/free-1980-midpoly-retro-rooms-203080
Simple Decorate House Plant	Used for different house plants	Deprecated/No longer available
Low-Poly Table Tennis Set	Used for Table Tennis racket	https://assetstore.unity.com/packages/3d/props/low-poly-table-tennis-set-181749
Low Poly Storage Pack	Used as shelving in cabin and baskets for desk, bin for prototype 1	https://assetstore.unity.com/packages/3d/environments/urban/low-poly-storage-pack-101732

Low Poly Metal Rack	Used for shelving	https://assetstore.unity.com/packages/3d/props/furniture/low-poly-metal-rack-213045
Office Supplies Low Poly	Calculator, Tape, stick notes and other office supplies	https://assetstore.unity.com/packages/3d/props/office-supplies-low-poly-105519
Fantasy Forest Environment – Free Demo	Used as base for terrain and environment	https://assetstore.unity.com/packages/3d/environments/fantasy/fantasy-forest-environment-free-demo-35361
Animal Pack Deluxe	Used for all the animals – rabbit, deer, wolf, bear	https://assetstore.unity.com/packages/3d/characters/animals/animal-pack-deluxe-99702
Cabin Environment	Used for the Cabin to store bow and other items	https://assetstore.unity.com/packages/3d/environments/cabin-environment-98014

Appendix D – Using the Framework

This Appendix entry will be used to break down the full process of using the framework, with suggestions and guidance following an example design process. This breakdown is aimed for designers, made easy to follow.

Step 1:

Begin by choosing your desired emotion as the initial step. Designing for an emotion, in the form of a word, can prove challenging in the absence of a proper measure. Therefore, as you make your emotion selection, position it within the circumplex model of affect illustrated in **Figure 75.**

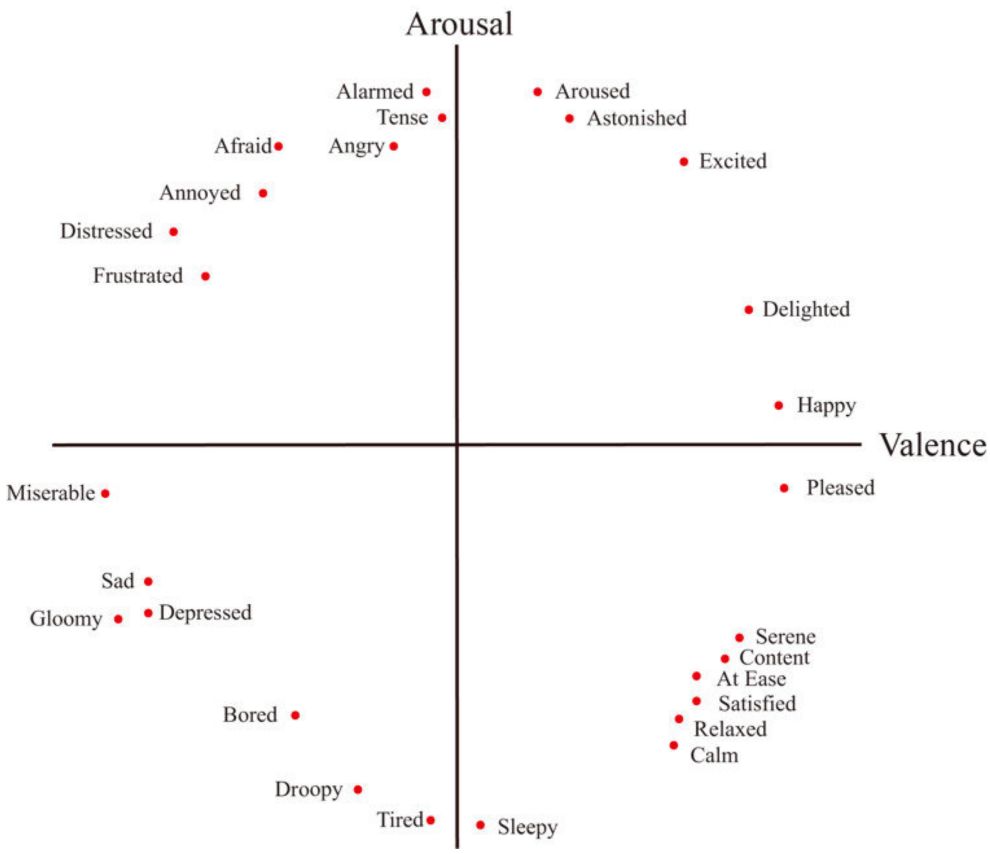

Figure 75 Example Circumplex Model of Affect

When you found a point for your chosen emotion, take into consideration other possible words that might be attributed to surrounding emotions. For example, if you chose calm, consider other emotions such as Relaxed, Satisfied, and Serene. The easiest approach to this is creating a circle around your emotion, encapsulating all the similar affective states you could elicit from your players, as seen in **Figure 76.**

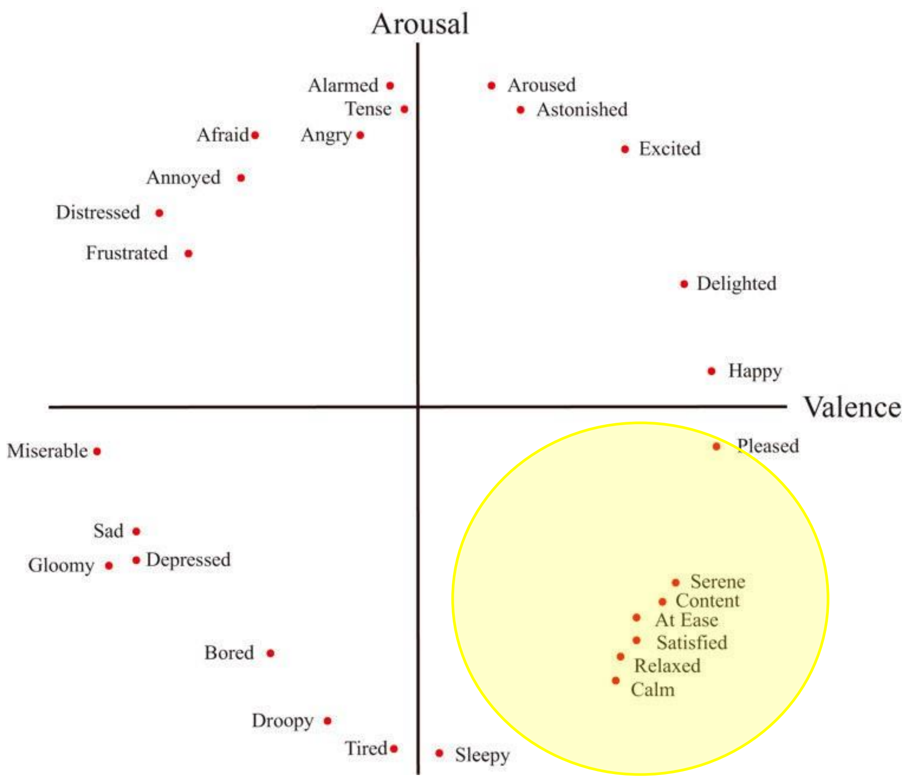

Figure 76 Emotions Around Calm

With a clear notion of the emotions you intend to evoke in your players through the mechanics you'll devise, you're now ready to proceed to the second step.

Step 2:

Now comes the time to reference **Appendix B**. Here we will look at example mechanics from VR games and explore the emotions they elicited. In this appendix entry, there are overarching mechanics – such as realistic physics system or interactions (diegetic UI and menus). These overarching mechanics have specific mechanic examples from existing VR games that fall into its category, alongside the emotions it elicits.

Therefore, there are technically two approaches possible. The first approach, followed in this thesis, is simply going through the mechanics one by one and identifying the emotions they elicit. Highlighting the similar emotions lets you identify all the potential existing mechanics that can induce the affective states you want.

The difficulty with this comes with the specificity of examples – we can't just take the design from another VR game and plop it into a new VR game – the context of the game matters. For example, the realistic physics-based gun system of *Half-Life Alyx* would not be dropped into *Walkabout Mini Golf.* Therefore, we have the overarching mechanics to refer to. If we were looking towards creating excitement, joy, and interest – perhaps we liked the mechanic of drumming in *Ragnarock*, then we can take a step back to its overarching mechanic – Two Handed Interactions/Interactions with Advanced Involvement.

The second approach is suitable for designers who possess a preliminary concept of the mechanic they intend to integrate. For instance, in the case of requiring a weapons system, in VR games, it's probable that the initial approach will involve a physics-based system. For example, if the designer need a weapons system in place, with VR games, the likelihood is it will begin with some sort of physics-based system. While the choice between realistic physics and whacky physics remains, as outlined in **Appendix B,** once this decision is narrowed down, the mechanics required for comprehending the emotional reactions are readily available within the provided table.

Step 3:

With our overarching mechanic chosen, we can now get into designing the individual mechanics. There are arguably multiple approaches to this step as well – dependent on how the designer likes to design mechanics.

Approach 1: Thematic

For this thesis, I chose a thematic approach. I identified the context of my games – for prototype one, a small room-based bedroom environment. I chose three themes/ideas of what the player could experience in a room – themes of cleaning/organising, relaxing/self-care, and then just playing around with everyday objects found in your room.

Knowing the setting and context, I then wrote down ideas for individual mechanics with the overarching mechanics in mind. For example, I chose two-handed interactions. With the theme of cleaning/organising in mind, it helped me identify the context of my mechanics, translating the existing mechanic examples in this overarching one. In order to reach a new mechanic, I thought of what item in a small room could result in a two-handed interaction. I also wanted to evoke the calm emotion that was identified through the repetition of two handed motions in *Ragnarock*, so I had to identify a two handed repeated motion, which led me to a broom mechanic.

Approach 2: Direct Translation

This approach is the most simplistic. Once you have an overarching mechanic selected, you can refer to the existing mechanics in the table. For example, let's create a new mechanic in the Health System example that focuses on delighted/happy/pleased. I have taken the table from **Appendix B**, which can be seen in **Figure 77.**

Combat – Stamina System/Health System Combining stamina and health systems in VR combat games introduces tactical depth. Players must manage their resources strategically, adding a layer of realism to battles. Developers should ensure that these systems are balanced to prevent excessive frustration and maintain fluid gameplay		
Game	Example Mechanics and Interactions	Potential Emotions Elicited
Creed: Rise to Glory	Stamina system where punches lose impact after quick succession. Blocking and dodging for stamina.	Frustration (diminished impact), Delight/Pleased (successful actions)
The Walking Dead: Saints & Sinners	Eating food or using health items to restore health Regaining health by consuming items.	Relief (health restoration), Gratification (successful healing)
Gorn	Stamina system where attacks are less effective when tired. Strategically managing attacks and recovery.	Frustration (ineffective attacks), Tension and Excitement (Tactical thinking)

Figure 77 Appendix B Excerpt (Health/Stamina System)

I appreciated the concept of replenishing health by consuming food in *The Walking Dead: Saints & Sinners*. Now, envisioning this mechanic in the context of a fantasy-based VR game, what equivalents might the player come across? The most apparent choice would be potions – enabling the player to simulate the motion of pouring a potion into their mouth. However, as game designers, we can elevate this foundational mechanic by infusing it with intricacies. This enhancement would lead to a sense of alleviation and satisfaction. However, my intention is to intensify the emotional impact even further, tilting the player's experience towards increased happiness and sheer delight.

Now, let's delve deeper into the example drawn from *The Walking Dead: Saints & Sinners*. In this game, consuming any scavenged food can lead to a reduction in maximum health. Only food crafted within a Survival Workshop can circumvent this effect. When it comes to crafting potions, a careful equilibrium must be struck to evoke delight. If I were to devise potions that prove ineffective or even harmful to the player, there's a possibility that the sense of delight would diminish. However, an alternative avenue emerges by introducing a mastery progression system. Through this, I can harmonize the potential for frustration with the heightened emotions of delight experienced upon succeeding (as evidenced in mechanic examples from the table). Hence, I could construct a mechanic centred around a potion crafting system.

Now we arrive at the exciting stage of expanding this concept into a full-fledged game. Introducing a potion crafting system calls for the inclusion of various ingredients. Here, I could adopt the overarching mechanic example of "Interactions – Hands On/Feedback" as outlined in **Appendix B** (depicted in **Figure 78**). By combining elements from different sources, I could devise a mechanic where players pluck leaves from diverse plants to gather ingredients. This would incorporate the intricate movements reminiscent of fine motor skills, akin to adding ingredients to a cauldron as observed in *The Room VR*. Additionally, I could infuse the pleasure and inquisitiveness associated with puzzle-solving, from *The Talos Principle VR.* Thus, I could craft plants that offer distinct methods of extracting leaves, flowers, or other components – integrating puzzle elements – which, once carefully washed and combined, can be placed into a cauldron.

Interactions – Hands On/Feedback

Providing hands-on interactions and responsive feedback in VR games enhances realism and player agency. Developers should focus on detailed object interactions and haptic feedback to create a tactile and immersive experience.

Game	Example Mechanics and Interactions	Emotions Elicited
The Talos Principle VR	Solving puzzles involving turret-like nodes, disabling shields, and creating circuits between switches. Physical interactions with puzzle elements, enhancing engagement and problem-solving.	Joy (solving challenges), Curiosity (exploring mechanisms), Anticipation (creating circuits)
The Room VR: A Dark Matter	Executing fine movements like picking a lock, twisting levers, and adding ingredients to a cauldron. Hands-on manipulation of intricate puzzle components to solve mysteries.	Curiosity (exploring intricate mechanisms), Awe (summoning magic), Focus (fine-tuning movements)

Figure 78 Excerpt from Appendix B (Interactions - Hands on/Feedback)

Step 4:

With the individual mechanics decided, there is of course fine-tuning and implementation into a game engine that would follow. For more precise design, it is also possible to research more into each example mechanic in **Appendix B**. Each of those mechanics have their own context, as seen with the health system by eating food in *The Walking Dead: Saints & Sinners*.

Nonetheless, due to its focus on individual mechanics, this framework is versatile enough to aid in designing multiple mechanics within a single VR game. Furthermore, the potential for expanding **Appendix B** is considerable through the assessment of additional VR games and the identification of mechanics they employ. These newly recognized mechanics can be seamlessly incorporated into the existing tables. Alternatively, if significant similarities emerge among diverse individual mechanics, the option to identify and incorporate a new overarching mechanic arises. For reference on how I evaluated existing VR games, you can refer back to **Chapter 4**.

Appendix E – Design Patterns

Hands on/Feedback

Design Problem (generalised):
VR offers a challenge in creating consistent and interactive feedback, as it requires a different set of considerations in its interactions and environments. To create curiosity and joy in discovery of interactions, and maintain such emotions, solutions need to be considered.

Design Solution:
Introduce the option to interact with all components in an environment, even if unnecessary for game progression. Options to provide more whimsical interactions if fantastical objects, or realistic interactions if realistic objects that replicate reality and players' expectations. Provide opportunities for haptic feedback to further immersion.

For reaching spikes in emotional state, common trends involve initial discovery of new interactions, unexpected performance of objects (in a positive way) and expected performance of objects (if highly realistic).

Terminology: *Indicators (visual, haptic), Feedback (visual, haptic), Interaction Performance (whimsical – no guidelines, realistic – form follows function)*

Example of this Pattern in Action:
In a VR puzzle game, players navigate a mystical fantasy forest teeming with interactive flora and fauna. Players may uncover secret passages by sprinkling pixie dust on ancient stones, causing them to glow and reveal hidden symbols. Another example could involve players coaxing glowing fireflies to gather around specific flowers with gesture controls, causing them to bloom and unveil hidden paths. These interactions evoke feelings of discovery and excitement as players uncover the forest's magical secrets.

Related Patterns:

- Physics (realistic)
- Physics (whacky)
- Interactions (Hands On/Feedback)
- Interactions (Diegetic UI/Menus)

Design Drivers:

- Game designer wanting to create positive emotions in scenarios in VR such as excitement and joy, starting from scratch on a new project.
- Game designer wanting to enhance existing mechanics/existing components of a game.
- A game designer interested in designing a VR game centered around exploration and discovery.

Realistic Physics

Design Problem (specialised):
In a VR construction simulation game, players take on the role of a skilled engineer tasked with building intricate structures in a variety of challenging environments. From towering skyscrapers to intricate bridges, players must utilize their construction expertise to overcome obstacles and complete each project within budget and on time. They need to have exciting and engaging gameplay, that gives them anticipation, tension, but also satisfaction.

Design Solution:
Introduce a physics (realistic) system, considering an accurate simulation of the behaviour of construction materials in a virtual environment, considering the properties and behaviours of different materials, such as weight. Options to provide more in-depth physics by furthering the interactions between each object. Enabling players to operate machinery, considering factors such as weight, balance, and momentum, could be considered.

For adding uncertainty in the system, create a system to further alter the structures of many parts all together. Consider a dynamic system with reactions to player actions and environmental conditions, such as structural stress, deformation, and collapse.

Terminology: *Physics (realistic), Properties (weight, tension, etc), Dynamics (deformation, stress, collapsable)*

Example of this Pattern in Action:
Players are tasked with constructing a bridge across a canyon, considering the weight of various objects that will traverse it—the player on foot, the player in a vehicle, and multiple occupants in the vehicle. Realistic physics govern the interactions, allowing players to adjust and place different materials such as connecting beams, cables, and supports capable of withstanding different weights and tensions. Anticipation arises from achieving optimal weight distribution and considering wind resistance. Excitement stems from the dynamic process of interacting with and manipulating all the components throughout construction. Satisfaction and tension go hand in hand as players continually test the stability of their build during the process.

Related Patterns:
- Physics (whacky)
- Interactions (Two Hands/Advanced Involvement)
- Interactions (Hands On/Feedback)

Design Drivers:
- Game designer wanting to create realistic emotions in scenarios in VR, starting from scratch on a new project.
- Game designer wanting to enhance existing mechanics/existing components of a game.
- Game designer wanting to create a specific emotional experience but is unsure how to design with emotions in mind.
- A game designer focused on developing a VR game with a strong emphasis on engineering principles and education and encouraging players to take proactive steps in understanding concepts such as structural engineering.

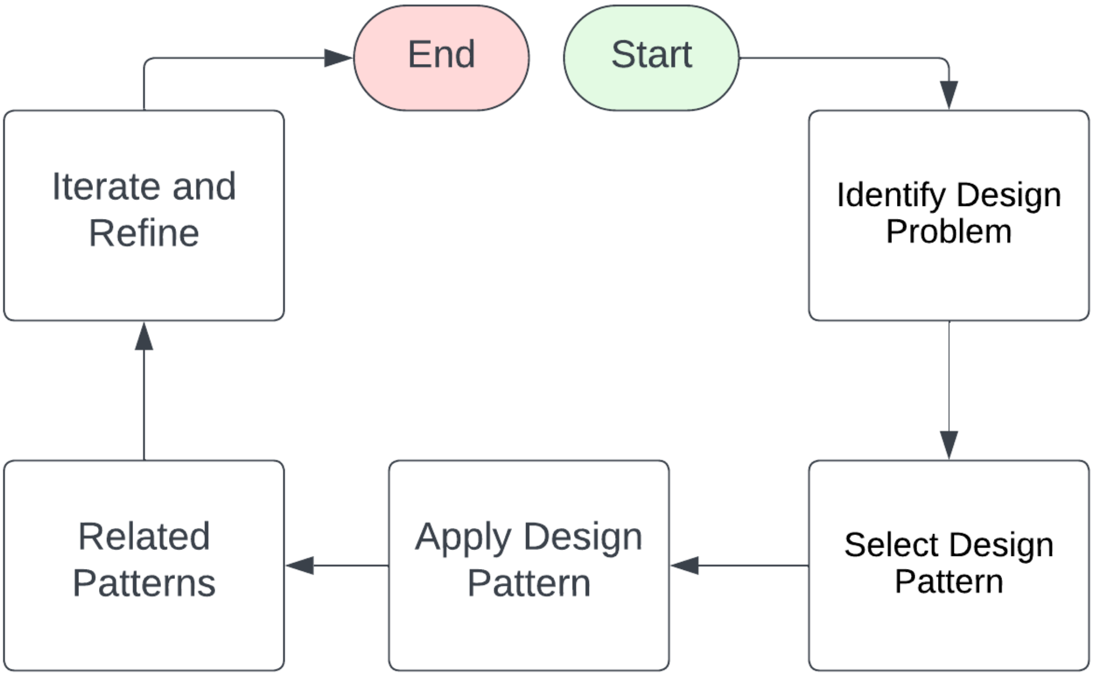

Figure 79 Flowchart of Design Patterns

Figure 79 showcases a flowchart on how to use this framework as a design pattern. The steps can be understood as follows:

1. **Start:** Begin with the initiation of the design process for the VR game or experience.
2. **Identify Design Problem**: Identify the specific design problem or challenge that needs to be addressed within the VR experience. For example, "Creating immersive environmental interactions". Or customize the design problem to a more specific issue.
3. **Select Design Pattern**: Select the appropriate design pattern/overarching mechanic from **Appendix B** that addresses the identified problem. In the case done previously, the "Physics (Realistic)" pattern was used.
4. **Apply Design Pattern:** Illustrate the application of the selected design pattern to the VR experience. For example, implementing realistic physics, but considering the individual components in the system, such as dynamics and properties in the physics system.
5. **Related Patterns:** Show connections to related patterns that complement or enhance the selected design pattern. For example, connections to "Physics (realistic)" could be "Interactions (Two Hands/Advanced Involvement)".
6. **Iterate and Refine**: To implement the system, the design process will involve iteration and refinement. If implementing just one mechanic, and depending on its complexity, this step may be greatly reduced.
7. **End:** Concludes once development is done, or looping back to the beginning if further iterations and more design are necessary.