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Utilizing Worldbuilding as a Means to Aid Relaxation in a VR Experience

MASTER DISSERTATION

Diogo Miguel Freitas Santos

INTERNATIONAL MASTER OF INTERACTIVE MEDIA DESIGN



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UTILIZING WORLDBUILDING AS A MEANS TO AID
RELAXATION IN A VR EXPERIENCE

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Sumário

A tecnologia tornou-se uma parte essencial da vida moderna, proporcionando benefícios físicos e mentais às pessoas com deficiências nestas áreas. No entanto, isto também tem contribuído para o aumento dos níveis de stress, especificamente em ambientes urbanos. No ambiente acelerado de hoje, há uma necessidade crescente de encontrar métodos de relaxamento rápidos e fáceis de fazer. Os meios de comunicação escapistas, como os romances, os filmes e os videojogos, proporcionam algum alívio tanto às suas narrativas como à sua construção de mundo incorporada, embora não visem especificamente ajudar no relaxamento. Esta tese centra-se em saber se uma experiência de realidade virtual pode reduzir o stress e a tensão nos adultos. A experiência desenvolvida é narrada numa ilha inspirada nos locais naturais mais visitadas da Madeira e incorporou uma narrativa construída no mundo demonstrada pela narrativa ambiental. Utilizando questionários, sensores biométricos e dados observacionais, foi revelado que enquanto pelo menos um terço dos participantes sentiu alguma tontura e tensão, a maioria relatou sentir-se relaxado devido a elementos sensoriais tais como visuais e sonoros, incluindo alguns dos voluntários com tonturas e tensão. A narrativa construída no mundo incentivou a exploração, embora os voluntários não sabiam de toda a história em detalhe. Este estudo demonstra o potencial das narrativas sensoriais para fins relaxantes, ao mesmo tempo destaca questões sobre as limitações de quem pode jogar em Realidade Virtual tendo em conta os limites da experiência e os seus elementos.

Keywords: Construção de Mundo · Caminhadas · Realidade Virtual · Sentidos · Saúde Mental · Elementos da Natureza

Abstract

Technology has become an essential part of modern life, providing physical and mental benefits for handicapped individuals. However, this has also contributed to the overall increase in stress levels, specifically in urban environments. In the fast-paced environment of today, there is a growing need to find quick and easy to make methods to help with relaxation. The escapist media such as novels, movies, and video games provide some relief from both their narratives and their built-in Worldbuilding, though they do not aim specifically to aid relaxation. This thesis focuses on whether a virtual reality experience can reduce stress and tension in adults. This developed experience was set on an island inspired by natural hotspots in Madeira, and it incorporated a worldbuilt narrative conveyed in environmental storytelling. Using questionnaires, biometric sensors, and observational data, it was revealed that while at least a third of the participants felt dizziness and tension, the majority reported feeling relaxed due to sensory elements such as visuals and sound, including some of the volunteers affected by dizziness. The worldbuilt narrative encouraged exploration, although the volunteers did not explicitly understand it in detail. This study demonstrates the potential of sensory-filled narratives for meditative purposes while highlighting questions about the limitations of who can play VR, taking into account the limits of experience and its elements.

Keywords: Worldbuilding · Walks in Nature · Virtual Reality · Senses · Mental Health · Elements of Nature

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1 Introduction

This thesis addresses the desire for meaningful connections with our surroundings and the common need for relief from daily tasks, often hindered by limited time or access to outdoor spaces. Designed as an alternative for those with tight schedules, which have shown to be common with adults in modern times [2], or physically or mentally handicapped, this experiment was designed as a virtual means to replicate similar relaxation. COVID-19 has shed light on this matter by encouraging the "smart Workplace" mentality in companies and discouraging people from doing outside activities as frequently as before [3]. However, at the same time, many people have shown an excessive need to return to natural environments, such as forests, due to not being able to leave home often, especially early in the pandemic [4]. This is often established in fiction, further expressing our desire to do outdoor activities [5].

Games like "The Legend Of Zelda: Breath Of The Wild" and its sequel encourage exploration and movement at high altitudes to inspire a sense of adventure and freedom [5]. The grandness and visual promise of the goal are enough to excite the player towards it, thus showing the importance of making an environment that feels open and unrestrictive for the player, which makes it a regenerative experience [5]. The inclusion of serenity within the level is juxtaposed with the adventure, intensifying the feeling when the player finds themselves at their destination. Therefore, "Breath of the Wild" replicates the meditative escapist feeling of outside involvement in vast environments such as of forest walks and beaches [6]. While several articles focus on using Worldbuilding or video games for immersion, few mention their use for relaxation purposes inherently, at least considering the number of the referenced examples used in this thesis [5, 7–10].

The feedback from all the volunteers on stress relief within the gameplay of the experiment of this thesis was gathered in Pre and Post-questionnaires, the first ones being of a shorter scale since it was designed to assess their initial state before playing the game. In these questionnaires, the volunteers shared their opinions, feelings, and path decisions throughout the gameplay. These questionnaires were designed to be open-ended to avoid influencing the response of the players. Throughout these questionnaires and the gameplay, in the case of needing more specific results, a wristband was attached to measure heartbeats per minute for additional insight, alongside notes gathered from the gameplay of the player.

In fictional media, there are a lot of elements that are essential for creating a complete experience to satisfy the consumer. The narrative in most of these media defines the tone and style for a specific target audience, captivating said consumers in a way that an effective and expressive conversation about a subject would with a full focus on it [11]. Thanks to its involvement in media, many messages, themes, and beliefs within narratives have influenced the mindsets of consumers globally, ever since the Egyptian times with their mythology [12]. This is due to the ability that storytelling has to emotionally engage the audience with the many elements in narration that subtly evoke rising or lowering escalation [13].

One of the more significant and captivating narrative components is Worldbuilding [7]. Worldbuilding is the narrative element that focuses on describing the locations, people, their culture, and items that exist around the journey of the protagonists and beyond. Though not specifically distinct as a narrative feature, it is used to bring life to the stories told in whichever way to bring believability, context, and immersion that adds to the story. Not only is it a major part of it, but it can establish the tone of the story in the way that the narrator interprets it, so it reflects the

tone of the story, presenting the nature of the environment, which is the setting of the stage for the events to unfold.

Some narrations evolve alongside the Worldbuilding, morphing as it goes on. One of the most peculiar examples is the epistolary fiction and metafiction novel by Mark Z. Danielewski called "House of Leaves". In it, the fictional narrator Johnny Truant attempts to make a documentary titled "The Navidson Record" presented as a story within a story discussed in a handwritten monograph. This narrative involves heavy use of multiperspectivity, in which the fictional author tries to recover and describe within his footnotes a manuscript of the experience of a family as they lived in a house with a labyrinth inside that is larger than itself, this being just a beginning of how far down the rabbit hole goes in his chronicles, as it progressively turns from an "ordinary diary" as the family members describe the elements within the house and its structure changing as their days go by, confusing them with their sense of familiarity and eventually getting them stuck into a nightmare reality within the house. This is expressed in the writing within the manuscripts in both changes of the tone of words and literal structure of the book, including the color, graphics, and textual layouts [8]. The story successfully grasps the reader as the narrator slowly loses control of the story, as it becomes more twisted, as if the mere mention of the events caused this. The novel successfully builds a vivid environment that not only details the bizarre scenarios the family gets involved with but also expresses well with the combination of the writing style change and the literal structure of the pages, making it ergodic literature.

While these are engaging narratives that explore a wide range of human creativity and thoughtfulness, they do not inherently focus on providing a relaxing experience to the user, at least as the main focus. The escapism they provide in the worlds they guide us through, which can also express internal beliefs or speculations, helps users alleviate stress [7]. However, some media have certain aspects, such as *Breath of the Wild*, with elements designed with true relaxation in mind, with its open world exploration [5]. Ultimately, it depends on what the author wants to say or express to the wide audience, which, in the case of this thesis, focuses on creating an experience much like what the latter does, focusing more on helping users relax.

1.1 Objectives

The goal of this experiment is to relieve stress to people who do not have time or are physically incapable of going for a walk in the woods, as well as to evaluate the added impact of worldbuilding, the elements of nature, and Virtual Reality.

Throughout this thesis, we will be exploring the concept of worldbuilding, what makes it beneficial, and examples of its efficiency, as well as the elements of nature that make up an emotionally immersive environment.

For this, we built a prototype that recreated the environment of a walk in the woods within a nature resort. In it, the players go through a multiple choice path experience in VR with a design based on walks in the woods and natural resorts on Madeira Island. The effect of the experience is based on the three immersive methods that will be explained in detail in the following chapter of the state of the art. These are VR, the nature elements that immerse us within its environments, and the effects of Worldbuilding, the latter being inserted as a story of past events marked and constructed so that the players can see them and thus comprehend his story.

To understand the outcomes of this experience, we designed an evaluation that analyzes if the users were engaged with the "story", and analysing the before and after effects. To summarise, this thesis explored Worldbuilding within a VR experience as a means to help people who either do not have time or are incapable of going on forest walks, where the experience takes place, as a means to help them relax.

The following Research Questions have guided the evaluation of this research:

1. How much can Worldbuilding help immerse the player within a VR experience intended for relaxation?
2. How does the culmination of Worldbuilding, Elements of Nature, and VR, affect the overall experience?

The thesis yields the following contributions:

- The Artifact is a VR experience made in Unity. In it, the player explores a multiple path choice level within an island resort based on walks in the woods on the Madeira Island.
- Concept art and development process of creating said VR experience.
- The results and their evaluation, which reflect the expected and final analysis brought by the volunteers of the experiment. This was analyzed in multiple methods with the goal of obtaining as clear of results as possible.
- Points provided from the results for the future of this and other studies that follow similar goals or methods.

1.2 Structure of the dissertation

This subchapter is an organized explanation of each section within the thesis with a summary, so as to understand their contextual sequence. These include the Introduction, Literature review, Prototype Design and Development, the Evaluation, Data analysis, Discussion, and Conclusion of the thesis.

The Introduction mentions the context for the creation of this thesis, stating the target audience as well as the immersion methods that will be described in the following chapters. Alongside this, it contains the Objectives that this thesis aims to fulfill.

The Literature review summarises the related work and state of the art, explaining their definition, examples, impact, and how they can help to discover how to accomplish the intended hypothesis. This includes Worldbuilding, Ambient elements to aid relaxation, and Virtual Reality.

The Prototype Design and Development chapter explains the process of the development of the experience, mentioning the technical, visual, and conceptual design as well as their justification. This includes Experience development choices, Concept Development, Biome divisions, Terrain, Vegetation, Narrative of the Worldbuilt story, VR Experience Gameplay Storyboard, 3D Models and revampments, VR Controls, Animation, Sound and music, and testing the level.

The Evaluation chapter establishes the hypothesis, the process, the demographics, and the methods for which to evaluate our VR experience. This includes the hypothesis and question, the Protocol of the overall experience for the volunteer, Measures and the Inclusion Criteria.

The Data analysis reveals the results gathered from the volunteering in the experience, according to the noted measurement methods. The Measurements are for the Quantitative Data Results, which include the Self Assessment Manikin (SAM), Activation-Deactivation Adjective Check List (AD-ACL), Player Experience of Needs and Satisfaction (PENS), E4 Wristband data which includes the Interbeat interval (IBI) and Electrodermal Activity (EDA) results, and finally the overall Qualitative results.

The Discussion chapter contemplates the results gathered in the data analysis chapter, contextualizing them to find out if they support the hypothesis and what they provide for the future works of the thesis.

The Conclusion chapter summarizes the concept of the thesis, the development of the experience, the major points gathered from the results, and points for future work.

2 Literature Review

This chapter of the thesis focuses on both the related work and state of the art, which explains the definition, utility, variation, and effect of the three methods that were used to bring more immersion into the experiment, as well as examples that show these being used and how they help with the intended goals of this experiment. These are Worldbuilding, the narrative structure of the story which is made so the reader is further immersed in the world that surrounds it, elements of nature, which express other elements that make going to the woods or at the beach such stimulant experiences, and Virtual Reality (VR), a returning technology to the popular media that aids immersion in video games and movies. This is all to help answer the hypotheses for the experiment, this being how much does worldbuilding influence a fully immersive experience intended for relaxation? And how does the culmination of these 3 elements affect the overall experience?

2.1 Relaxation

Before talking about these methods used to aid relaxation, it is important to establish what it is and how these medias can help people obtain it. Relaxation is a state of mind which helps the body and mind relieve from tension [2]. Relaxation techniques are cost-effective, safe, and practical, and they can be used for various techniques and practices [2]. These include continuous muscle relaxation, guided imagery, deep breathing, calming music [14], yoga and meditation exercises such as Tachi and Shavasana, most of which involve restorative environments such as within nature [14, 15]. These can be utilised to foster a state of relaxation, positive wellbeing, and better the state of mental and physical health, proving to help with cognition, respiration, cardiovascular disease, body mass index, blood pressure, digestive arrest [16], diabetes, and joint disorders. Thanks to these improvements, relaxation stabilizes the heart rate, blood pressure and help bring positive emotions as well as reducing mental distress [2]. It is also important do distinguish that stress relief focuses more on calming muscular tension and heart rate, compared to relaxation [17].

2.2 Worldbuilding in media

Worldbuilding is an important part of narrative structure [13]. While the main goal of most narratives is to show the development of characters, their goals, how they respond to challenges, and whether they manage to overcome them, it is the world in which they develop as characters that makes these adventures all the more captivating [7]. The world around the characters in the story essentially ensures the believability of the story [7]. This is important so that the moral or concept the story provides becomes more acceptable and understandable.

The best way to explain the structure of Worldbuilding and its importance in a narrative is to show examples used in the media [7].

2.2.1 The definition of Worldbuilding

Worldbuilding is a narrative device that allows an author to describe the world in which characters live. This refers not only to the geography they encounter or have been in but also to the details of the wider region and world narrated by the characters or narrators [7]. One example is Middle-earth in the Lord of the Rings books by J.J.R. Tolkien [7]. It detailed not only the current state of the world, its inhabitants, houses, objects, and culture but also the past and possible futures of

these elements [7]. This is necessary to make the story more believable, not if it is realistic, but that these fantastic species, places, and customs require relevant skills, struggles, and interests to hold the interest of the reader [18]. This is similar to how people like to travel to learn about different cultures and lifestyles in real life and invest in them because of the human element involved [19].

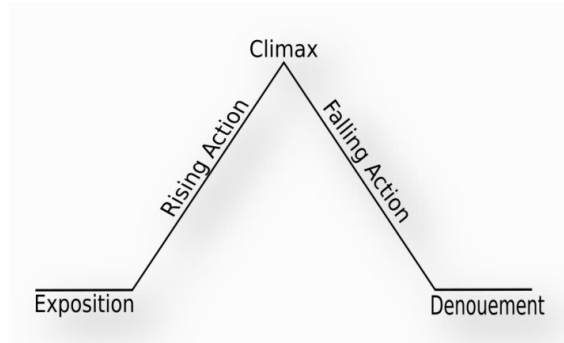


Fig. 1. A basic diagram of plot progression in a narrative [1]

Across all narrative elements, worldbuilding continually works to bring the story to life within the context of the main conflict [13]. Although there are many examples of defining narrative structure [20], seven elements are consistently present in most studies: plot, setting, characters, point of view, style, themes, and conflict [1]. For example, as depicted in the figure 1, the Plot has a traditional structure that, while not requiring all steps, defines the progression of the narrative [1]. While not all of these are necessary to create a complete narrative of a fictional world, using as many of them as possible will promote immersion in that world, thereby providing useful elements for analyzing the structure of worldbuilding [13].

2.2.2 Immersion strategies within Worldbuilding

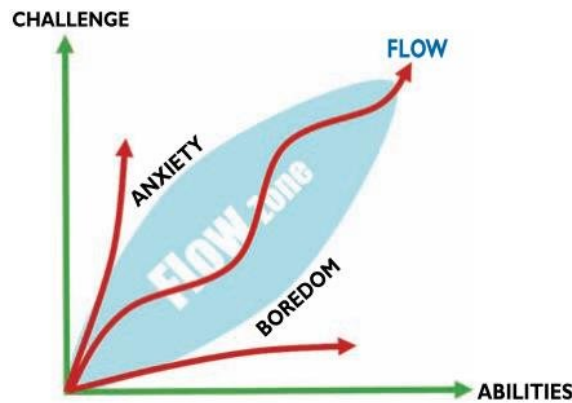


Fig. 2. The Flow Zone between enthusiasm and boredom

Beyond making readers invested due to what the narrative says, there are other methods that authors use in media to add investment of the interest in the narratives, while still finding a middle ground so as not to make it too enthusiastic, since that would mean they would feel unfocused, especially for when they do other activities [21] (see figure 2). There are also ways to keep consumers

engaged with unfinished Worldbuilding storylines. One of the most famous examples is the way Charles Dickens ended his continuous stories with an unfinished scene, usually with high stakes [22]. This means that the fictional world and its narrative have been created so immersively that the consumer needs to know what will happen, and therefore wants to buy the next piece of media [22]. This method has not only been shown by writers but also in most media, notably with television series aimed at a younger audience, with usual success [23].

The narrative can also switch between time frames to remind consumers of old plot points or to retroactively add new plot points into the backstory [24]. This can also serve as a nod to future storylines to add focus to the current narrative moment. These techniques show that this fictional world is continuous and therefore more immersive [24]. All of the elements described so far demonstrate how to effectively combine narrative with worldbuilding to enhance the consumer experience [23].

2.2.3 Related Projects

Besides AAA products, which the acronyms only represent high quality titles that have shown their effects, the EMMA project is a prototype of 3 environments that share the same park structure and design, but differ in weather and time of day. This was used in an experiment conducted by Giuseppe Riva et al [25]. Their study evaluates if VR is an effective medium to induce the same effects as movies deliver emotional, behavioral, and physical responses from the context the volunteers are in. They test the effects of stress relief in a virtual experience within these environments, to see the effects of emotions through presence, manipulating sound and music, shadows, lights, and textures. While expected in their experience, since the environments that were made to be anxious or relaxing were so, it was detected that the emotional state was influenced by the level of presence and vice versa, a continuous cycle of effects between them as opposed to the way more influenced by the intensity of the emotionalness. They also got used to the elements of the environment first in a neutral version, to ease through the experience [25]. The method of analyzing the variables defined the emotional environments as A or B, with the neutral one as C, although they were randomly assigned to experience these maps in random order. While outdated, it is a good example of how this kind of experiment can be conducted effectively.

In contrast, the study made by Ea Ehrnberg Ustru et al. [26] uses pressure to help players adapt to the difficulty of a game, alongside measurements of Heart rate or electrodermal activity (EDA), both being linked with arousal, and self assessment questionnaires such as self assessment manikin (SAM) as means to comprehend the game experience and see the correlations among the measurement methods. For the context of our thesis, these measurements, besides pressure, help understand that the more, say, EDA happens to the player, the more arousal they feel, thus being important to have as low as possible for an analysis such as our own.

Another article by Giuseppe Riva and Daniela Villani [17] uses the "power of presence" in a VR environment as a means to develop emotional psychotherapeutic results for the users. According to this article, one of the least explored health fields within VR environments is the stress management area, this being one of the main mental health problems of western societies. To solve this matter, they have compared three relaxation techniques, these being VR, DVD, and Audio speakers, utilizing their developed therapeutic narrative and a protocol based on progressive muscular relaxation. Having a "control group" that had no treatment in the study as well, 60 university students were divided into the four experimental procedures. For both VR and DVD groups, there

was a significant improvement in the emotional state with noticeable psychological changes, as well as a relationship between the sense of presence and outcome gathered by the relaxing experience, according to the regression analysis. However, proof that the main element for presence may be from the content shown in the relaxing experience, since there is an absence of significant analytic differences between the groups.

2.2.4 The impact of Worldbuilding throughout medias

While activities involving nature help ease the mind from hard work, it has been shown that stories are also a substitute for these kinds of activities, plenty of times mixed with, such as how children imagine their characters from fantasy and play pretend with others. This kind of activity is why many play video games, as this is a more direct way of experiencing fiction. In games like Legend of Zelda: Breath of the Wild [5], the player goes through vast lands filled with all kinds of environments, cities, and dungeons to loot, recreate, save imprisoned species, and empower equipment to progress further, eventually reaching up to the villainous Calamity Ganon and defeating him before he finishes destroying the world of Hyrule [27]. The distinction of this game comes from the creative liberty the player has to utilize the gathered equipment as the adventure progresses. Defeating enemies, solving puzzles, and, exploring the world of the destroyed Hyrule will always change depending on the methods the player chooses [27]. He can climb mountains, fly off them with a paraglider, run or ride a horse through the fields, use magical abilities to help work with physics puzzles and cook with what the player can find for health points and more abilities [27]. It brings many interesting perspectives on how to explore environments freshly. It incentivizes the player to explore and go through them as they choose how to, just like tourists love to travel, remembering places and creating their own stories with the new places they go to [28]. However, they are incentivized to immerse themselves in the world from the gameplay. Some games do not have to be open world to achieve the same effect, such as Super Mario Odyssey, which have similar levels of creativity and exploration, which have been proven to help people with Major Depressive Disorders (MDD), both dealing with depressive moods, motivational training, and visuospatial memory functions [29].

An example of relaxation in video games involves environments that, in concept, convey negative feelings because the topics are so heavy that personal issues may be expressed and therefore relieved. Ekman et al. [9] mention two popular examples of horror in video games that utilize character motive as a strategy to move forward the story, both of which share this hardening theme of loss. Silent Hill 2, made by Team Silent and published by Konami [9], starts with the current goal of the main character, James Sullivan, which is to find his wife. However, he states right away that she has been dead for 3 years, so immediately it is shown that there is more context that needs to be revealed, which is what the town slowly provides as the story progresses. It is ultimately revealed that his wife was terminally ill and unable to leave her bed for a long time, to the point that James could not take it and eventually killed her. Many figures around town resemble his feelings towards this event, including other visitors who are dealing with their own living nightmares and apparitions. Respectively, there is Angela, who is also trying to find her family, although it is implied she has been in distress because of them. This is much more implied as the game goes on, since her next appearance, she is attempting to commit suicide, which is stopped by James, who she offers the knife she was going to use. Maria is another inhabitant, although she shares plenty of resemblance to his wife, except she is more sexualized. She is constantly hunted down and killed by one of the more present monsters in the game called pyramid head, who is also seen trying to kill

James frequently and raping other feminine-looking monsters. It is implied to represent the sexual frustration and anguish of James for murdering his wife, which is why he is always seen doing horrible things, due to him not accepting his failures. Beyond this, the final boss is a malformed version of his bedridden wife, which further exemplifies the tortured imagination of James and self-loathing, as expressed by Ong Sher Li [30], although the rest of the games in the series follow the same general structure [31].

The Self-Determination Theory by Christina M. Frederick and Richard M. Ryan [32, 33] expresses the importance of the exploration of the psyche. It focuses on the three factors that help or weaken the core type of intrinsic motivation in sports. These are listed as competence, relatedness, and autonomy, which in this study have been shown parallel to invisible agency. The conditions of Flow of State activities, described by Csikszentmihalyi [33, 34], are the activities that will create an engagement with everyday life to result in satisfaction. These conditions apply to general media, such as videogames: Goals completed, instant feedback, challenges that test the skills of the player, deep focus, feeling in control, sense of time is altered, and The activity is intrinsically rewarding. Sercan Şengün [33] states that the invisible agency of this game is transformed and taken out of context, it is not directly told nor entirely implied until the very end and is seemingly open to the choice of actions of the players. Things such as escorting Maria through and through, finding important items, reaching places and ultimately the number of items used or found will depict the outcome of the fate that James gets afterwards. This assessment of autonomy is almost a reflection of the term agency [33].

The way the adventure of James is presented reflects the way that treatment of trauma in a person is made, getting the context through the more normal and appealing side of the scenario of the person, slowly but surely figuring out the situation that they dealt with and thus eventually coming to terms with their trauma [30]. This is much like the experiments made to test the effects of video game violence like the article of Ruf et al. [31] where they use a narrative exposure therapy-like method.

The following studies show that narrative experiences may require strategies to help users comprehend what the media entails and the concentration skills of the readers. In this study, Humphrey O. Obie et al. [35] compare the use of visual elements to see if it aids in reading a short and long-term story, revealing this to be the case. Narratives also have been proven to make people invested in the journey they embark on and thus give them an interest in the subject matter [36]. So the narrative world in general, thus worldbuilding, is an encaptivating tool that, while effective, needs its strategies to help the average consumer comprehend the content [35]. So we believe it is necessary to help ease people into an uncharted subject matter or a reality they are uncertain of [28]. As we grow older, there will be more people who will likely feel this way due to the increasing commonality of technology in the average life of a consumer, since we have more difficulties in accepting something new and moving away from the way we are used to work or socialize. In this article, Divine Maloney et al. [37] talk about the utilization of VR headsets as a means of socializing, watching videos, and playing videogames, mostly when the COVID-19 pandemic was in full swing and people, especially teenagers, needed to interact with other people in a more close bonded way. While it was an effective method due to the situation, harassment was a problem, and having to use it often proves it to be addicting, discouraging outside activities from it such as working and potentially affecting their confrontational social skills outside of the game [37]. Even if there is proof of media being problematic to users under certain circumstances, mostly the

mentioned, it has been suggested to be beneficial for multiple purposes, such as for people suffering from Major Depressive Disorder on decreasing its symptoms, training motivation, and visuospatial memory improvement during the experience. Even if it is not concrete information, its suggestion proves to have some efficiency in the effect of the experiment [29], beyond the aforementioned effect caused by games such as Silent Hill 2.

2.2.5 Movies and presentation methods

Worldbuilding shows a lot of potential when it comes to affecting the real world with its tone, helping enforce ideologies brought in the narration [36] and helping with the potential mental health issues [29]. As mentioned in the introduction, plenty of media took advantage of the way they brought attention to their worlds in an effective way that made a full explanation of the tone of the scene not necessary, due to the world around giving the same idea away [7]. There are some genres that take more advantage of this than others, most notably the horror genre, due to its contrast to reality and often jumping to a more surreal method of storytelling to point out its message, just like the mentioned book, "House of Leaves" [8], and the videogame, Silent hill 2 [9].

Another example of horror stories that follow this principle is "The Shining" by Stanley Kubrick, which is based on the Stephen King novel of the same name. It features a family entrusted with the responsibility of managing the Overlook Hotel, which is situated in an isolated region of Colorado, throughout the winter season [10]. The ability that this movie has on evoking fear to the audience without over-relying on supernatural elements is noteworthy and demonstrates the subtlety and nuance involved in creating a truly terrifying experience [10]. The proprietor subsequently discloses the details of a tragic incident on the previous supervising family that took place before their arrival, as they engage in discussions on the property deeds. This disclosure serves to foreshadow the eventual descent into insanity of the father figure in the family, Jack Torrence [38].

The careful use of suspense throughout stories such as this one is a major driving force to make the narrative interesting. The novel describes the characters and their social problems which are further explored as the hotel morphs Jack, revealing his failings as a father, husband, teacher, and writer. The rest of the family also reveals the truth about their broken relationship, especially Danny, who acts as both a child and an adult through "the shining", clearly as compensation for the parental abuse, as mentioned in the article by Maria Anastasova et al., which describes the novel [10]. Later on she mentions notes from articles of Noel Carroll [10,39], which mentions that suspense, as a response to fiction, is "an emotional concomitant to the narration of a cause of events, which course of events points to two logical opposed outcomes, whose opposition is made salient, where one of the alternative outcomes is morally correct but improbable (although live) or at least no more probable than its alternative and the other outcome is morally incorrect or evil, but probable". She also introduces the term "erotetic narration" which implies that "(...) scenes, situations, and events that appear earlier in the order of exposition in a story are related to later scenes, situations and events in the story, as questions are related to answers" [10,40]. These setups make the reader consider the many outcomes that the story may provide in their mind, "which the narratologist can represent as questions" [10,40], thus investing them further into what the answer is in the narrative. This is further intensified depending on the way the stories are expressed.

According to the article of Maria Anastasova et al. [10], there are three main concepts from the narrative theory that she adopted for her analysis. The voice is the way the character takes us through the story with their own perspectives, the focalization is about what or which of the

characters sees what causes them to react and time, such as the order these events occur, represents how long and how many times the characters react and interpret. The analysis of the suspense in "The Shining" creates fear and hope based on the events that transpire, one of which is morally correct, but unlikely to happen and the other one vice versa in both aspects. This novel divides itself into five books, which, retrospectively, introduce the characters, locations, and paranormal elements. Afterwards, suspense increases as the story goes on, beginning the inevitable downfall of the family, which leads to the final chase and climax. These are the micro-questions, which "organize the small-scale event in the plot, even as they carry forward the macro-questions in the story", that give way to the macro-question, the elements that appear throughout the story which add up and relate to the ending, as told in the book of Carroll [40].

The Worldbuilding was ultimately used for a major point of immersion in the experience for this thesis, being the inserted worldbuilt narrative within its world.

2.3 Ambient elements to aid relaxation

The escapism that worldbuilding brings the same appeal as traveling elsewhere [28]. To relieve the stress of the day, people like to go to different environments where they can relax [14]. Going to the beach is a common practice because of the appealing looks and colors of its vastness, the rays of the sun illuminating the environment and the soothing sounds of the sea as it hits the sand and rocks [6], the seagulls singing and flying in the background alongside the presence of people adding into the dynamic flow of the environment is necessary for our senses to be rebuilt [15].

The city environment may influence the mood of people throughout their day without them noticing the influence it makes [41]. This is mostly due to the potential stressful scenarios, such as when there is traffic on a work day. Regardless of this, the amount of noise made by the vehicles and their loud buzzing worsens the situation, adding to all the gas from all the vehicles [41]. All the pressure from this travel is then brought into the workplace.

To replicate the qualities of natural habitats for a more immersive experience, it is necessary to understand what makes them alluring to people [15].

This subchapter will focus on certain dynamic elements referenced within worldbuilding, giving focus to what makes these desired environments so peaceful, beyond the visuals. It will mention what they are, what they can do, how they influence, and at the end, how they come together to make a space that channels people to their relaxing overtone.

2.3.1 Sound

Ever since the 1940s, the concept of immersive sound has been put to the eyes of the public, with "Fantasia" by Walt Disney, in which music sound would travel from the left, center to the right ear or vice versa [42]. Eventually, after the popularization of stereo sound, came the existence of surround sound, which is comparable to the former, but localized usually in a 360-degree angle from horizontal and vertical planes [43].

Technology has reached such a level of distinct detail with sound that many specific points can be brought to attention besides easy distinction of the tone of them [44]. As expected, dynamic sound has become a possibility, which means being able to focus on a specific sound amongst multiple others or having a sound become quieter as attention to it ceases to become a possibility in any media [44]. Soundscape ecology is the composition of other sounds that complete the ambiance within environments, the addition of the sound of anthrophony, meaning from man-made items, geophonic, which are nature-made sounds like the weather, biophonic sounds, from animals or people, and orchestral instrumentation [45]. Thanks to these technologies, communication with other people, for example with video chatting, becomes better due to replicating the face-to-face interaction with other people in a more captivating manner [46].

The "Body, Sound and Space in Music and Beyond: Multimodal Explorations" book by Clemens Wöllner contains plenty of articles related to experiencing sound in unique ways and its effect on the human body, both physical and spiritual reactions [47]. Here are some of the mentioned points that fit the context of this study:

Eitan, from one of the articles mentioned in the book, emphasizes the cross-modal interactions of motion, touch, and vision, focusing on the interrelations between these senses by examining the closeness of multimodal mappings in terms of valence, affect, or associations between static

and dynamic states [48]. Specifically, experiences involving dynamic changes offer insights into perceptions that explicitly link spatial and bodily characteristics to pitch. Exploring these aspects of pitch and musical movement provides valuable information regarding fundamental questions in music cognition and theory [48].

In film, sound plays a pivotal role not only in directing the attention and expectations of the audience but also in influencing memory processes and emotional reactions. Building on the 1994 concept of synthesis by Chion [49], which integrates temporal synchronization and semantic synthesis, Fahlenbrach explores multimodal metaphors, as mentioned by Eitan [48], that are essential to the construction of meaning in film. Thus, the sound design of films creates visual and auditory gestalts, which, in this case, is a set of psychological principles that describe how humans perceive and interpret visual and auditory stimuli, that shape cross-modal correspondences and embodied meaning. In four case studies, spatial gestalts are highlighted as metaphorical source domains, illustrating both lower-level perceptual processes and the development of more complex narrative and cultural meanings, with particular emphasis on how sound can shape perceptions of atmosphere and space. In Chapter 10, Christiane Neuhaus employs the metaphor of music as "fluid architecture" to describe spatial characteristics attributed to organized sounds. Several studies that were discussed provide evidence for the fundamental link between spatial information processing, music learning, and perception, as well as navigation and spatial cognitive functioning following exposure to music. By referencing spatial processes concerning music-making, Neuhaus positions these findings within a research tradition that views bodily and spatial concepts as foundational to embodied cognition [50].

There is also mention of the reactional experiments, which show that music makes the body move, even if a little. Test performances show constant patterns across sessions, showing that the body can adapt well to different situations, though movement varies according to the sound music. According to Alexander Truslit, it even follows a specific style and, according to certain listening conditions, there may be a "high individual movement" [51]. Adding to this, the selected sound characteristics were related to the spatial position data of the participants.

Grimshaw reviews philosophical and neuropsychological approaches and highlights relationships with immersion, which became a key term in computer gaming research [52]. Building on these concepts, the main part of the chapter investigates the influence of sound on perceptions of presence in gaming. "Sonic virtuality" should strongly increase feelings of presence, which are not only tied to real settings and places, since sound has a key role in changing the perceived realism in games, while at the same time stimulating imagination and fantasies [52]. Grimshaw presents examples of recent developments in virtual environments and computer games, in which interactions with the body of the gamer further shape the way sounds are perceived. He concludes that some of the sonic concepts of perceived presence may even have consequences for real-world settings [52].

Other topics include performance improvement depending on the spatial form of the work environment, predictive processing, and reward processing giving rise to the sensation of empowerment when synchronizing with a beat. Peter Lennox develops a virtual technology that almost creates full 3D audio, both surround sound and distance sound, to experience an entire musical environment and the "vivid spatial dimensions in music are thus vital for rich and satisfying perceptions" [53]. Brereton encounters developments of virtual performance spaces, with acoustic manipulations and modern advances in computational techniques that can create realistic sounding and musically rich virtual scenes for musicians [54].

These points further incentivize focus on sound elements throughout the VR experience. The sound that nature provides helps with creating relaxation; it was in our interest to simulate its effect on users [52].

2.3.2 Ambience Music

While sound can be enough for some media to make the experience feel complete, regardless of the genre and piece of media of the topic, most often music is needed as an extra element to make the most out of an experience [55].

There are many examples of the use of sounds based on nature to turn otherwise cacophonical noises into ones more appealing [14]. Tai Chi are physical exercise practices that heavily involve smell, space, and sound [56]. A lot of it is oriental music with gongs and calm singing to help the listeners control their tempo within the exercises. This is designed to help them focus on their movements and control their "chi", which is made as the person breathes calmly in a way that softens the body, creating a greater effect on the exercises [57]. There is also music that fits in this calm tone that is a mix of ambience and sounds of nature, such as whale sounds deep in the ocean or sounds of currents [14], mixing in with more instruments such as tambourines, and harmonic singing with piccolos alongside it. These sounds are what they usually use to make "zen" music, intended to make people relax after an intense exercise [56]. In this exercise, called Shavasana, the person lays down on a comfortable surface and loosens every part of the body, entering into such a calming state that it loosens muscular and organic tension [58]. The entire exercise routine is amplified and encouraged with the use of this very kind of focused music, added by the metaphorical and focused words spoken by the master in timed moments within the song [59]. These effects combined help those resting to stop focusing on their thoughts and instinctive worries. For example, someone may have a digestive arrest from all the things they had to focus on in a day, and thanks to this exercise their stomach can function properly [16].

Ambience music does not have to reside only in meditative exercise. Countless music genres convey different emotions and tones while utilizing the same strategies [16]. Both the classical and popular genre utilizes multiple instruments and singers of unique tones and kinds of sounds to help elevate the intensity or quantity of sounds, depending on their loudness [60]. This combination aids the echo effect, which makes the music more pleasing. This is why so many people like to go to theaters or shows to listen to music genres like these [60]. The same technique used for watching movies at the cinema is used to a similar effect, which is what other genres usually take advantage of, the ambient effects, even some concerts [60].

Movies and musicians prefer that people focus on the media they provide when they are in these environments, since people tend to exchange their energy with the environments they are in, which is why these are designed to help them focus on it further [61]. In this article, for example, Maria Gatti et al. focus on utilizing ambient music for an emergency scenario, much like how we use it to help with our work environment [61]. In this case, they experiment on the intense and overworked one of a hospital [61]. Through rhythmic vibration sound waves, music can bring a receptive state for the human senses. This helps the person reduce stress and tension due to activating the production of endorphins, helping the mind create imagery that takes them into a "painless world" for a while, essentially becoming sheltered by imagination then. This translates "waves" of pain sensations into energy or healthy vibrations, which is sound. This also decreases anxiety and helps with clarity of thinking. The researcher experimented for the first 6 hours for

the shift of 49 professionals working in a private hospital. During this time, 1:30 hours of Johann Sebastian Bach music would be played, then another 1:30 hours would go by until it would be replayed, since until then no music would be on, meaning that it played twice during the daytime and evening shifts. Although most of these volunteers preferred other genres from classical music, the effects that were made for this work environment were considered positive with a 76 percent approval rate. From this 76 percent, 85 percent say that it helped them focus on their task, to give them a good mood, relax, be stress-free and more [61].

2.3.3 Weather

Sound and music are usually the earliest elements that people take into consideration when relaxing in natural environments because they contrast with what they are used to in their city life [6]. However, its effect is far from the only one that revolves around the ambiance and beings that bring the totality of the feeling the locations bring. The weather and time of day have a lot of influence on how the effect should be made to correlate with the tone of the area, for example [6].

The weather is a great source for defining the activity and emotions given within the day in the media [62]. Health activities such as the previously mentioned Tai chi need a sunny clean sky not only to make the exercises better but the feeling and scent added by the atmosphere help to make them a more comfortable activity [56]. The emotional impact of weather is expressed within fiction as well, though as a narrative context representative [62]. If the world of a character shows to be in a pessimistic state, it usually rains, as for the example of the world of "Blade Runner" film series made by Ridley Scott, based on the novel "Do Androids Dream of Electric Sheep?" by Philip Kindred Dick [62].

The weather can significantly impact the tone of a story, as demonstrated in the experiment of Oscar Rehnberg [63]. Users preferred virtual environments with dynamic weather elements, such as rain, clouds, and wind, over static ones [63]. In addition, lighting effects, such as light rays, play a crucial role in creating realism and credibility in video games and movies. By bouncing light around the environment, the visuals of the scenery are enhanced and brought to life [64]. Occasionally, it is a common practice to express what types of characteristics the protagonists of a given moment will embody, similar to how the beach is typically associated with summertime and its warmth [15].

There are six units considered within a realistic visual rendition of the weather. The temperature affects cold or heat within environments, such as how in "Outward" when the player is required to use warmer clothing to combat the cold, otherwise suffers from a movement penalty [63]. The atmospheric pressure changes depending on the altitude the player is at influences the movement made due to the force that the wind or hurricane makes in games like "Just Cause 4", interfering with how the player controls their parachute [63]. Humidity is often shown from where the rain strikes, so the precipitation falls from the clouds and the cloudiness that is generally shown, the gameplay aspects of it are shown in scenarios such as in games with driving like "Just Cause 4" [63]. The use of these elements, beyond making the game more realistic, makes the experience within video games much more immersive [65]. Adding dynamic elements like this in a fictional world makes us more invested in exploring it. In this example, Okanovic Vensada et al. recreate multiple areas of ancient Rome to guide users through re-created historical events and meet figures, standards, beliefs, how the average day of a citizen was, and more [19].

2.3.4 Time

Time is another element that relates to other elements, such as the seasons, influencing the weather. In other media, it is used to set the scenes and make them a thrill, more notably in single and multiplayer video games [66, 67]. In the latter, time does not usually work in the way that single-player games do, being tracked by a timer that may or may not differ if the players accomplish part of a mission to prolong the current round [68].

In the realm of single-player video games, time can be a significant narrative tool that can be utilized in numerous ways [66]. Certain events that occur can establish the tone for the rest of the game, like in "Half-Life" by Valve, Inc. In it, the player character, after installing an alien mineral into a machine, creates a portal that opens a rift to the base in which resides an alien army, which invades Earth, leading to the ensuing disaster that sets the adventure of the game in motion. This game was designed as a long level, at least giving the illusion of it. This means that the whole game does not have a level selection menu or moments of pause to change the levels, besides having to load the next section or a moment of conversation with a survivor. Because of this, the tone of the game is never interrupted, thus helping the player have a consistent feel of immersion in the action as they get used to it [66]. Because this story is on a constant rush and never establishes any jumpcut or change from the norm, it has a more linear narrative frame for its fictive timeset as you progress through the game.

Time can often be consistent in games, following a clock-like pattern, particularly in open-world games. The Grand Theft Auto series employs time as an integral aspect of the gameplay, shortening the 24-hour cycle to accommodate the fast-paced gameplay. Nevertheless, the in-game actions, such as driving around town, take as long as they would in real life. This sort of timelapse has been designated as gameworld time by Zagal in his article [66].

2.4 Virtual reality and associated technologies

With the recent advancements in technology, it has become easier to create believable fictional worlds that immerse users in a way that captivates their imagination [69]. Dynamic environments are more immersive than static ones [63] and virtual reality (VR) technology has made it possible to replicate them with the use of its tools. These tools include ones that focus on surround sound [43], smell products [70], movement products that are controlled with the legs [71], hands and goggles that allow users to see the virtual world as if it were their own [69] usually defined as the head mounted display (HMD). VR has brought forth new possibilities in creating virtual environments that have the potential to replicate the elements of nature that affect us in a similar manner [25]. The purpose of this subchapter is to highlight the progress made in VR technology and its capabilities and evaluate its effects on users.

2.4.1 Extended Reality

It is important to consider the various technologies that are related to Virtual Reality (VR) before delving into its tools [72]. Extended Reality (XR) is an umbrella term that encompasses a collection of computer-generated technologies that simulate real-world environments and enable user interaction. This category includes VR, AR (Augmented Reality), and Mixed Reality (MX), which combines both VR and AR [72]. AR enhances real-world environments through digital visual elements, sound, or other sensory stimuli. Such technology is commonly utilized in training environments, where real and virtual objects are combined, often within devices like Android and iPhone models [73]. Microsoft Hololens is an example of a tool that utilizes both AR and VR, enabling users to interact with virtual objects in the real world through hand and foot gestures. One of the more popular applications that use VR equipment is "VRChat". In this game, players from all around the world socialize with each other by utilizing in-game modeled avatars of their choosing and items that they show [74]. They can interact with one another just as they would in social media while being more "face-to-face" with each other within a plethora of map areas from closed areas, like restaurants to open areas like hills [74].

2.4.2 VR Devices

Research into VR hardware and software for video games started as early as 1968 by Ivan Sutherland and his student Bob Sproull [69], but most equipment was too expensive for consumer use, and its use for games was limited. In the late 80s, with the help of Jaron Lanier and Thomas G. Zimmer who were both former programmers who worked in Atari, Inc., they created the VPL DataGlove [75], which, after working on a contract under Nintendo and Mattel to build a lower cost version of it, would inevitably involve into the Power Glove. The Power Glove was one of the earlier more famous mass products made involving VR technology, where the user would control their Nintendo Entertainment System (NES) with the motion controls of the glove [75]. Even though it sold well, it still had problems adapting to the NES library, thus the technology was still too young to create an impact. In the middle of the 2010s [76] VR Technology evolved in a way that could be used as low-cost, consumer-grade hardware, most famously with the Oculus Rift.

In addition to this, the technology has become more immersive with the introduction of accurate positional and eye tracking capabilities, surround sound 3D audio effects [43], and VR controllers that aid in more instinctive interactions within applications [77], alongside other add ons such as

the Omni One VR Platform, which simulates movement through footwork, adding to the overall realism of the experience [71].

While the VR headset is enough to satisfy its users, the desire to interact with the virtual surroundings is inevitable [77]. Headsets like the HTC Vive use controllers that can also replicate the movement of both hands of the player within the virtual world, although not slow and precise [77]. This allows the user to utilize their fingers and hand position to interact with items, non-playable characters, and the environment like real life, although not as accurately as the headset movement [77].

Advancements in technology have led to the creation of the HaptX Gloves, which can detect touch within VR. These gloves utilize hundreds of microfluidic actuators, referred to as inflatable balls, which are placed next to the skin of the hands to simulate touch from smaller objects with air and pressure. The device also restrains hand movement when the player is holding an item to simulate the structure, further immersing the user in the virtual environment [78].

Technology has advanced to the extent that a virtual environment can replicate smell [70]. Although the technology is still in its infancy, products such as the ION, developed by OVR Technology, are capable of capturing thousands of smells from eight aroma cartridges [70]. This technological breakthrough demonstrates how far technology has come in simulating reality in a virtual world, as mentioned in the research conducted by Kristen Cowan et al [79].

2.4.3 The effects of VR on users

The use of virtual reality (VR) technology is known for its immersive experience [69] and technological advancements [76]. However, it is not without its side effects, which have been noted throughout its existence [80]. One of the main issues with VR headsets is that they can cause dizziness and motion sickness, leading to nausea, vomiting, and in severe cases, sopite syndrome and vertigo [80, 81]. Users can also lose dynamic visual acuity while moving their head or body, which affects their balance and posture due to the use of similar but different kinds of motion in VR [81]. Additionally, it can cause dry eyes, blurry vision, twitching eyes, eye strain, and fatigue [80]. However, users with pre-existing eye conditions can still use the device while wearing their prescribed glasses to experience the 3D effects of the VR headset [82]. While VR sickness or cybersickness [83] is not persistent, overusing VR can lead to symptoms such as dissociation, depersonalization, and derealization, which last only for a day if the individual refrains from using the technology the next day [84].

While the overuse of VR devices can lead to harmful consequences [85], it has been proven to help those with mental issues of multiple degrees [86]. There are many disorders in which people are hindered from having normal interactions with others in everyday scenarios, usually from suffering from some sort of inner anguish like depression or a syndrome that makes social interactions tougher. There are multiple applications like the previously mentioned VRChat [74] which has proven to be effective in helping people with stress, depression, anti-social syndromes, and mental disorders [86], although the effects within groups are not consistent with how successful they are [87]. VR technology has also been used in school education with a notable appreciation of the students due to the familiarity of what the technology provides, although a medium between it and traditional student-to-teacher interaction is needed [88]. In cases of mild cognitive impairment (MCI), which is a transitional stage between normal aging and dementia [86], VR technology has been observed to be potentially beneficial. It was shown to help some of them keep their

minds active for notably longer periods in cognitive training, as noted in this article that uses the Montreal Cognitive Assessment (MCA) and executive function. VR technology has been shown to enhance hand-eye coordination, depth perception, reaction time, visual memory, peripheral vision awareness, and eye-related treatments such as Amblyopia and vision loss [87]. Some experiments have been conducted that use VR as a means to influence the mood of users. The EMMA project is an example of VR being used to help users relax. Although this experiment tested with stress relieving and inflicting scenarios, it is proof that VR can influence the emotions of the users on a substantial level [25]. In another study, Blasco Vaquero et al. utilized VR technology to help users relieve stress in a location within 4 virtual 360-degree environments, these being chosen at random. Between this part of their experiment, two evaluations of their current state of mind were made, with the one before enforcing stress on the player so that the effect is further revealed. Due to this, the players always left the game more relaxed and satisfied, which ultimately accomplishes the intended goal [89]. While either of these environments involves interaction, the mere presence, visuals, and sound that the game provides is enough to influence the mood of the players, in this case, for meditative means, even making some of them want to return to them if they would have it at their homes [89].

This chapter establishes the potential effect of VR for users as a tool of immersion within plenty of situational contexts, including relaxation ones. The use of VR is mainly to obtain stimuli from said scenarios within a smaller timeframe and at any place where it can be set up, without being too expensive for the average consumer can obtain. So, for the sake of the experience, only the HMD and its controls were used for all points established.

2.4.4 similar VR experiences

The experiment from Stefan Liszio et al. [90] follows the use of VR for relaxation purposes and helps to endure stress. In it, using the assumption based on previous studies that the restorative effects of immersion, which are based on engagement, strengthen the sense of presence and help to focus on the point of interest, which they used videogames as an example. To test this, they developed a VR app that takes place on a beach with two different modes that consist of two casual games: a non-interactive mode and an interactive mode. Comparing the heart rate variability and psychological measures of stress between the groups that played either version, they found that the latter had the greater result. They hypothesised that the intense immersion, relaxation, and joy made by this version of the experience made the stress resistance better for the volunteers. Adding to this, while not as clear of an observation, the spatial presence in the VR app significantly added to the positive feeling during the stress phase that came with either version of the experience, which was added to ease comparison with the effects of the experience.

The article by Matilda Annerstedt et al. [15] utilize two different virtual forest environments as a means to study the effects of sound to alleviate stress. In it, they use the Trier Social Stress Test to induce an acute stress effect on users to evaluate how this environment helps with relieving from it. To do so, they studied the effects of three unique conditions: "a virtual forest including congruent sounds; the same virtual forest with no sounds; and a control condition with no virtual forest or sounds". To analyse the results, they collected Cardiovascular data and saliva cortisol, revealing parasympathetic activation in the group that listened to sounds of nature in the virtual forest, revealing that these scenarios enhance stress recovery. The results show a potential mechanistic link between nature, its sound, stress relief, and the potential of VR in this field.

The article by Nan Zeng et al. [91] reviews the state of VR articles that are aimed at aiding anxiety and depression with physical exercises. To evaluate this, they first used 10 article databases using the combination of terms such as "(“virtual real” or “mental health” or “anxiety” or “depression”)". They then checked on the eligibility of the criteria, such as if it was published in English between the year 2000 to 2017, if they used VR equipment only, either immersive or non-immersive and if it used "quantitative measures in assessing anxiety- and depression-related outcomes". Finally, they then extracted all the data and "rated each study using an 8-item quality assessment tool", checking which resulted in positive or negative results, summing how many of each there were of the total 407 articles. The findings favor VR exercises, since these articles show improvements in mental health for the two conditions.

Another study that follows the goals of this one is the one made by Simon Riches et al. [2], who have created a VR experience for relaxation aimed at those who were affected at the time the COVID-19 pandemic occurred. In it, they take the users in a visual audio stimuli narrative experience in a VR environment to promote relaxation, using the Effective Public Health Practice Project (EPHPP) quality assessment tool, having a "systematic review of feasibility, acceptability, and effectiveness of studies that use VR to promote relaxation in the general population". Although results were revealed to be inconsistent and required more robust studies involving VR experiences, this study expresses the potential effect of the use of VR technology for relaxation for the general population, especially in contexts of stress worldwide, such as in the case of the COVID-19 pandemic.

2.5 Literature Review Discussion

In this literature review, many findings helped establish more details, advantages, and disadvantages about the topic of each of these chapters. Worldbuilding exposes readers to the extent of the world surrounding the story of the characters, making it more believable and immersive. It usually consists of seven structural elements, and it uses a plethora of strategies to further hook readers into the media to consume more. While Worldbuilding establishes the importance of the world around us, other elements beyond the visuals of our surroundings enhance our immersion in the space we find ourselves in. In the case of the stories that the Worldbuilding is made for relaxation, they provide mostly notable effects, especially if they involve natural elements as seen in examples of said chapter, such as in Shavasana exercises [58]. Keeping in mind these points will help with creating a narrative that is potentially engaging and immersive, which in theory would help the eventual players of the VR experience focus on the elements of relaxation. While the line between Worldbuilding and a story narrative is not clear, there are examples of stories that take advantage of this to create a subtle narrative that incentivizes readers to analyze the clues given to figure out the bigger picture, such as Silent Hill 2 [33]. The narrative of the VR experience took this in mind, creating a narrative that is found out from the worldbuilding found by the player.

Other elements of relaxation involve sounds that can accumulate to ambiance music, using means such as surround sound and 360 audio, spaces designed to intensify these such as the theater, with such effect on the body due to the mixture of sounds that it encourages actions and movements. With this in mind, beyond creating environments based on a multitude of forest treks in Madeira Island, the importance of sound choice and its placement increased, due to the details and effects these articles state. The addition of weather in the environments shows both the intended mood of the narrative and the challenge of the situation, taking into consideration 6

factors. Time defines the weather and elements around the world, in addition to influencing the gameplay style of the gameplay depending on the genre and the goals given to the player, whether it is single-player or multiplayer. While it is not amongst the biggest priorities to focus on every aspect noted in these subchapters, keeping in mind the visual interpretation of the weather and reminder of the lack of time limit always helps with the effects of the experience.

VR and the overall XR technology have had many iterations that have shown its worth through plenty of means, such as educational, both theoretical and training, and enhancing the immersive effect of media such as in movies and video games, which have been proven to help users with emotional disorders. However, overuse has shown its problems due to causing effects such as dizziness and motion sickness. The examples stated beforehand have shown how immersive VR can be for any media, such as how VRchat works as a more effective means of distant social interaction [74]. The applications and games in VR encouraged us to create this experiment with VR as a basis for an attempt to help users relax in the virtual environment. While this VR experience will try to simulate the process of going on a trek in the woods, it will try to balance these health precautions with the immersion as it is being developed.

The rampant technological advancements have opened up new vistas in the field of virtual reality, allowing the replication of various real-world activities and environments. However, this led to contemplation over the extent of its effect, comparatively, when these replicas of real life experiences were hindered for certain reasons. The allure and pleasure of exploring the wilderness or open spaces, such as beaches, where one can relish the sensory experiences without being overwhelmed, is critical for fostering good health. The hypotheses of this thesis, which will be mentioned in the Evaluation chapter, rely on the efficiency of the VR experience. Its design takes the basis of these subsections of the State of the Art as a means of stress relief. While other experiments focus on these themes, this one intends to replicate the experience of going through the treks in the woods as an attempt to simulate the feeling that these places provide in real life, specifically for anyone unable to go there.

The literature review ultimately gives the idea of how Worldbuilding, the ambiance of nature, and VR immerse people emotionally within their means. While the goal to create a videogame that emotionally aids players has changed since the start, the acknowledgment of these has helped to shape it in a way that still follows the hypotheses, which will be mentioned in the Evaluation chapter, due to answering the means and elements that create a more effective experience. Beyond this, these sub-subchapters helped to define the ideology behind the level design, turning its goal into the simulator of a relaxing walk in the woods. The choice for the theme came due to the lack of articles mentioning the use of VR experiences that focused on providing this sort of experience to those who cannot go through the real life equivalent. The criteria for how this experiment was made and conducted are mentioned in the Evaluation chapter, shown after the construction of the Artifact.

3 Prototype Design and Development

Eventually, we created a VR experience to help users relieve stress and tension. This was designed to be as immersive of an experience keeping in mind the contents of the state of the art, utilizing a game engine capable of bringing the referenced elements throughout the state-of-the-art and related work sections to life, in a way that users could use it in a short amount of time. The focus of this chapter is on the major steps of the creation of the experience. This includes the evolution towards the final design and concept of the VR experience, events, terrain, and vegetation and the steps of the experiment from the perspective of the volunteers and researchers. Beyond this, it talks about the models and their animations, wildlife and water placements, controls and testing of the VR experience, general sound choice and placement, and the tools that were used in the experiment besides the computer and experience.

3.1 Notable Experience development choices

The development of the VR experience started earlier than expected because of the probability of potential issues that could have happened in Unity, which were proven to be of common occurrence, especially for projects with bigger ambitions and goals. They became more prominent by the time the plug-ins for the VR technology were inserted into the program. Other issues included the functionalities of features in the experience, texture rendering issues, attachment problems, general progression, and visual issues that needed to be fixed. Beyond the issue of the bugs of the experiment, it needed to take place in a soundproof room to help volunteers focus on the experience. This is because the Meta Quest 2 VR headset does not cover the ears, so to lessen the sound outside of the experience, the experience took place there so the player could focus [48].

It was also not possible to do the experiment with players who were outside of the lab, since not only is it uncommon for people to have headsets, but they most likely do not own the specific heart rate measuring wristband used for this experiment due to its hefty price. Alongside this, it would be harder to tell and note how the player was feeling throughout the experience because the researchers would not be in the same room, and even if their camera was turned on, the players would instinctively worry when acknowledging this. Beyond this, there could be problems with the equipment that they would have to use for the experiment, due to potentially being too old or damaged.

Due to the limitation of time to learn enough about programming in Unity, other software was used as the means to help with the event system of the experience. Game Creator 2 provided a quicker alternative to this matter, essentially creating a grid that automatically creates code so that the developer does not have to worry about how to code the programming sequence. For example, due to the number of visual effects that have animation and complex landscapes with the number of asset models placed to fill the VR experience, they had to be hidden until they entered the line of sight of the player. Using collision spheres to detect the location of the player, these areas and animations would activate and appear on the map while removing others that the player could not see in the chosen spot (see figure 3). In normal scenarios, the occlusion system would solve this issue, since it is supposed to hide what is not in the line of sight. Unfortunately, in this project, it did not work as intended for unknown reasons.

Most of the animated additions were not from the animation of the models but were a product of the particle effect system, more specifically the effects that create the illusion of the waterfalls

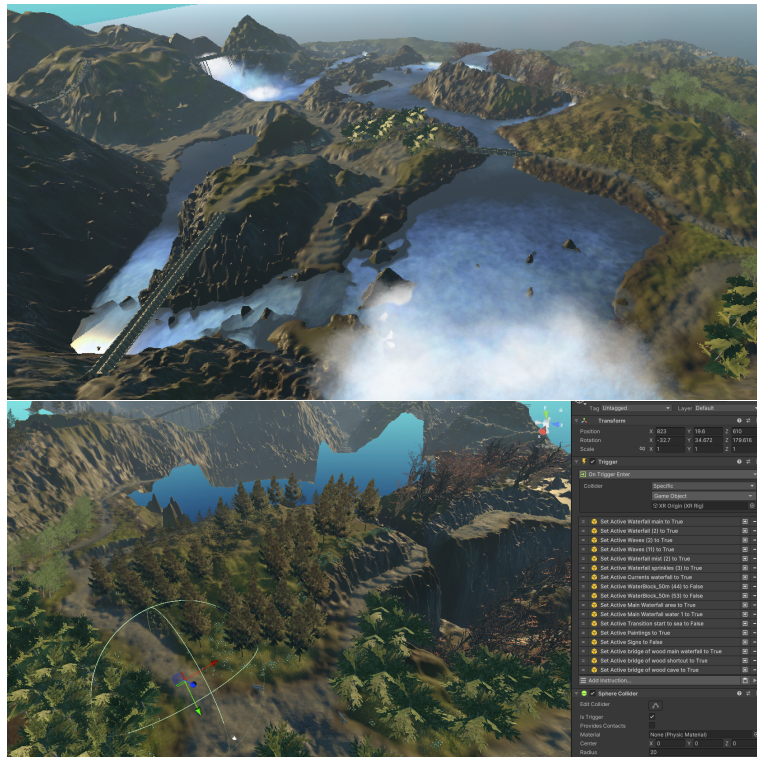


Fig. 3. Before and after using events to spawn the main section of the VR experience

and moving rivers (. These required a multitude of steps and different particles which made the effect resemble a realistic resemblance to the real thing, all of which follow the steps of this YouTube guide on its creation. This essentially shows things such as the use of time for the growth of the particles and the duration of the animation, color and transparency throughout the animation and gravity and collisions of the images, so that the way they fall resembles of the weight of water (see figure 4).

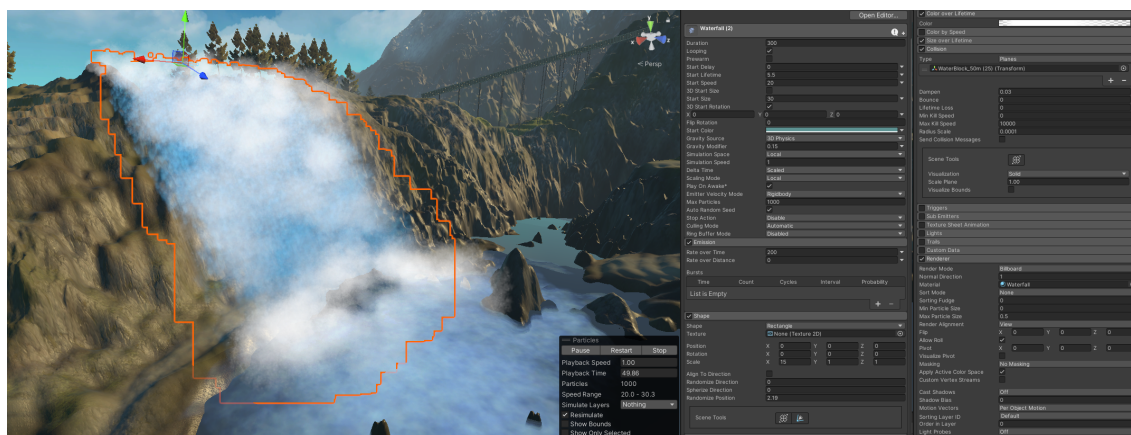


Fig. 4. The settings for creating the main waterfall of the experience

3.2 Concept Development

A key aspect of the VR experience was that the narrative was presented solely through worldbuilding since this method was the main driving force and most distinguishing part of it.

It was revealed in the research for the VR experience that there are plenty of media that show the potential of what a narrative can bring to an experience due to how it can be both entertaining or comforting to the players, as shown in the state of the art and related work subchapters [5, 30].

Among the brainstormed ideas, was the concept of making a VR experience based on a combination of the places in Madeira that have treks in the woods, which was the concept for two projects made before the thesis with Augmented Reality (AR) technology. At the time when this thesis was beginning to be developed, we found that numerous parks and forests around the island were getting heavily littered, to the point that certain articles note the equivalent of millions of USD worth of damage these vandalism acts cause in environments such as these. This only becomes more likely to get worse due to the ever-increasing amount of tourists appearing in countries such as Taiwan, causing cases such as this national forest park [92].

This desire for getting a break this way came to mind, due to many people finding it difficult to find an opportunity for experiences like this, either for being too busy to find the time for it or, in a worst-case scenario, not being able to do it at all due to health reasons. Because of this realization, which also gave the idea of where the experience should take place and what would it be about, it was decided what the reason for the creation of the VR experience was, alongside giving these people this situational virtual alternative that tries to simulate as much as possible.

At the same time that the concept was being developed, the technological aspect was also considered, especially the engine and headset that would be used for the development of the VR experience. The Game Engine Unity was chosen for the development of the experience, and the Meta Quest 2 VR headset was from where it was played in.

The conceptual artwork was based on the treks in the woods in Madeira, such as "Caldeirão Verde" or other places such as "the Biological Park of Funchal". While remembering going through said places and looking at images of them, the design of the VR experience mostly became a mix of them, alongside other places with a view. The idea of the paths passing through rivers connected with waterfalls was set early in the development since one of the articles shows that similar sounds such as those of rivers are proven to be effective in helping anyone in the surrounding area relax [41]. Another idea that was settled due to the same circumstances was of the multiple choice paths that would help the player feel less imprisoned in the VR experience [27, 28].

Another reason for adding multiple path options was the potential issue that certain places of the VR experience would scare players instead of calming them down. For example, one of the potential paths has the player walk in bridges that connect between hills. Their height could be great enough to scare them if they are afraid of heights, so instead of going there, they have 2 other different path options to choose from. There was also the possibility that, because it takes place on an island, it would make the experience unsettling, especially when adding in the castaway story, which will be mentioned later in this chapter. However, this was not changed, since only in high altitudes of the VR experience could the player even tell. As shown in these map designs, there were many iterations of the VR experience as the development in Unity went along, especially in the biome sections, and the order in which they would be placed within the ambiance (see figure 6 and 7). The following illustrations are some of the concept art to help give off a more accurate

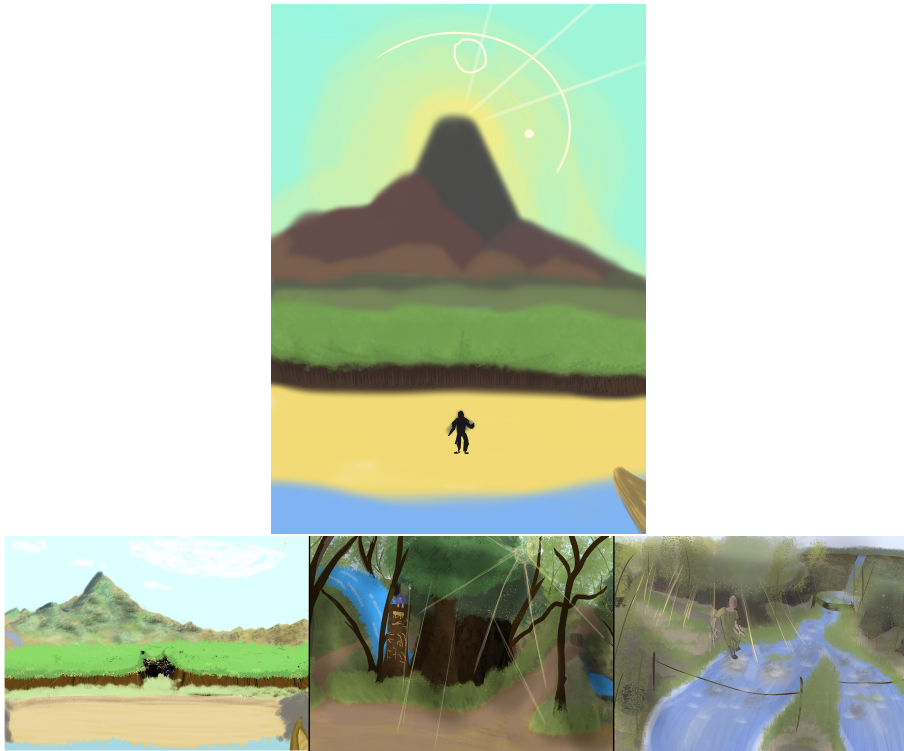


Fig. 5. Concept art for the looks and ambiance of the VR experience

tone for the ambiance, sections, and general design of the world within the experience, as it was important to be able to take in the surroundings (see figure 5).

3.3 Biome divisions

The experience focuses on an island experience in which the player goes through plenty of environments designed to help them relax, while constantly showing something different in some way. This is because while people desire, in this case, to find peace in places like this, if they are going through the same thing constantly, they will instinctively grow tired of it [35,36]. Because of this, the need for variation within the experience is important to refresh the mind, another aspect that brings appeal to tourism [28]. The way the level design of this experience was made makes it so that the whole experience is never interrupted. This method appears in games like Half-Life, which shows how with a consecutive gameplay style, the flow is never interrupted and thus the mood of the scene stays for longer [66].

Variety in the experience is another reason for the use of the multiple path choice idea, although, much like a trek in the woods in Madeira, these paths are linear, being illustrated by a sand-like texture lane. In the earlier designs, there were seven biomes that the player would come across with a certain similarity since they took place on one island. These different biomes help the player distinguish the parts which they find themselves within the VR experience, most notably because of the different elements found within said environments, which help make the experience of the player more immersive. The weather was only set to a sunny day, as it aids in the mood aimed for this experience much like a walk in the beach would [15]. Adding to this, besides for those who have a smaller tolerance to VR, there was no implementation of time within the game, as the player is intended to roam and enjoy the environment. In earlier plans for the experiment, some

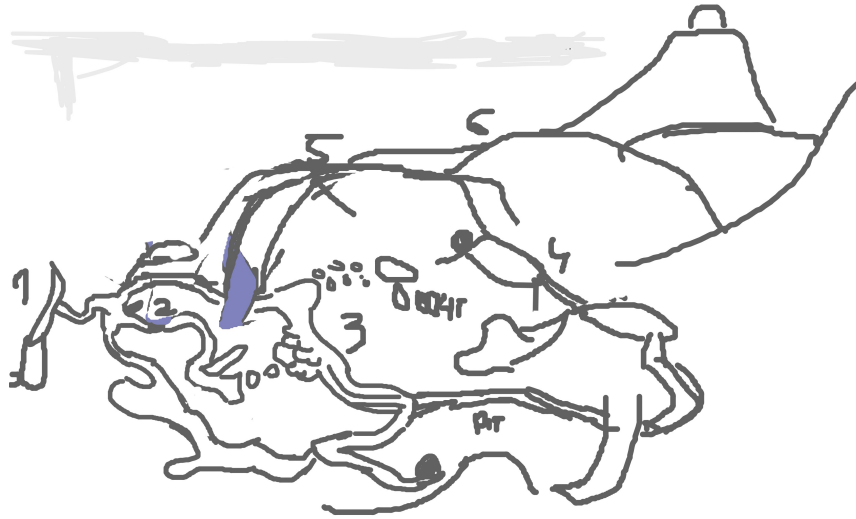


Fig. 6. Earliest makeshift of the island's map, to help illustrate the progression of the VR experience



Fig. 7. Second concept art for the map, to help decide the looks and elements of the sections

scenarios had the player interact with the ambiance, which would have the player do specific tasks to progress, displayed in the concept art figure shown (see figure 5). One of which had the player hold on to ropes as they went through a stronger river that led up nearby to a waterfall. Ultimately, ideas such as this were abandoned since they would make the experience too tense, even for the milder situations.

The way that biomes are divided throughout the VR experience were the beach, forest, swamp, hills, mountain river, canyons, and the final mountain, as depicted in the image ahead (see figure 9). While the island is designed with this sequence in mind, the level has been designed to have multiple choice paths, as seen in the graph (see figure 8), to make the experience feel more open for the players. This is important due to help them pick the path which fits them best and in the chance that one of them involve a phobia they have, to make the experience replayable so its easier to feel the same experience in return and as well as to make the experience shorter due to any reason, wether is time restrains or dizziness. The choice of biomes both reflects the ones in the forest treks in Madeira and those referenced in the Literature Review, such as sections of in-game biomes, such as those from *Breath of the Wild* [28] and *Half-Life* [66]. The way they are noticed resembles how some of the Shavasana exercises have the master talk about peaceful scenarios with music resembling the environments that they mention [59]. Ultimately, this created a mixture of an explorative experience with a peaceful undertone to it.

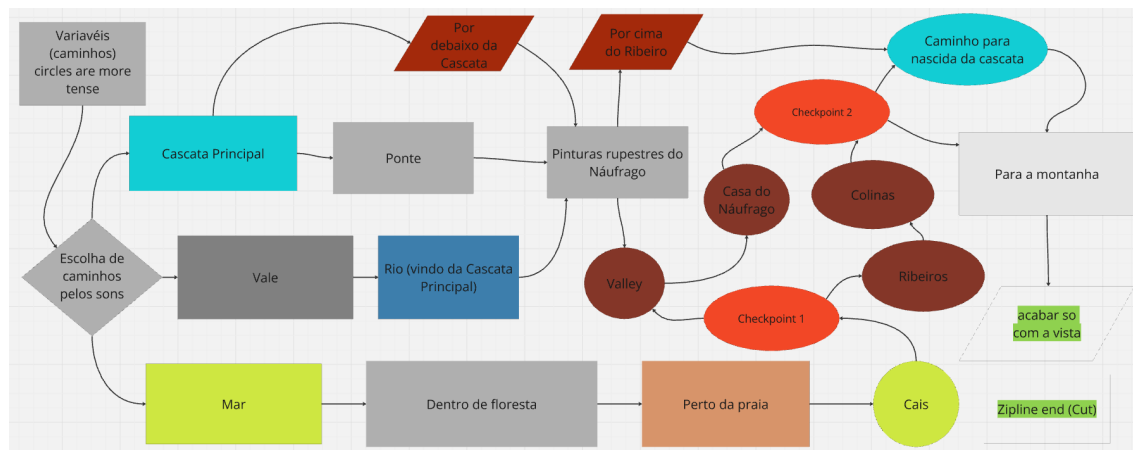


Fig. 8. Graph of the path progression of the level of the VR experience

The caves were made as secret passages to go through unique sections of the VR experience and in some cases were shortcuts. However, while it would be fairly simple to create a mesh in the blender program to replicate the cavern structure, the issue appears in the reflections inside, which is not easy to make believable, considering that texturing in normal lighting was already difficult to polish. These were the original shortcuts, and due to the limited visuals of the caves, the idea was to use the reflective effects from the outside as visual stimuli.

The construction of these biomes started with the terrain structure. This figure depicts one of the earlier stages of the development of the VR experience (see figure 10). The VR experience was structured in a way that replicated the path made in the illustration, which followed a design that would show the progress depending on the altitude the player would find themselves in, keeping in mind how the player would see the views. While the idea of the areas was settled, there was a

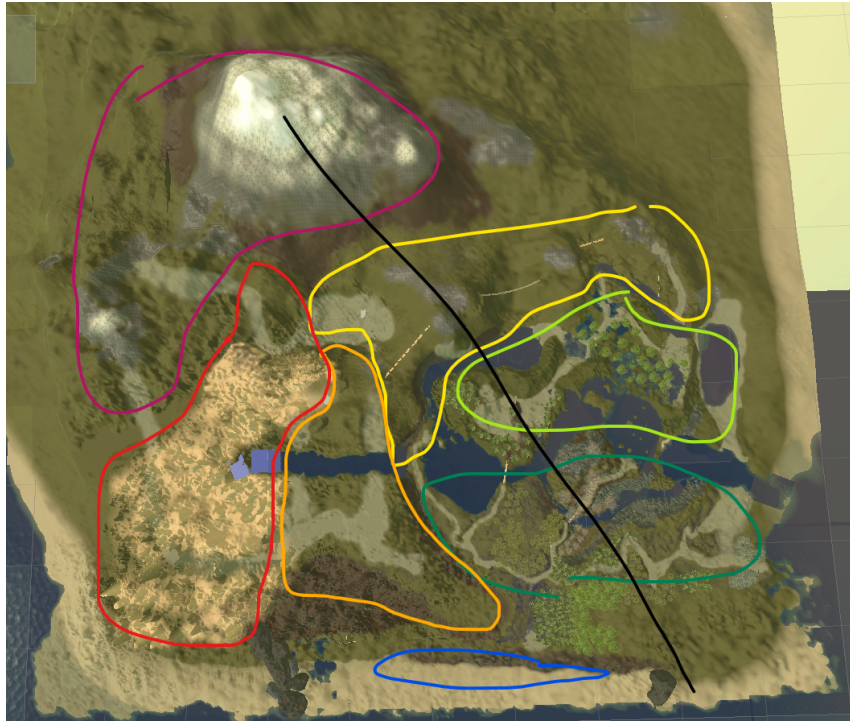


Fig. 9. A top-down view of the old VR experience design divided by the referenced biomes, each with their point of interest

need to experiment on how the biomes would segway into the next one as the player would walk along the path. A visual depiction of how the water would flow through the VR experience was inserted before the replacement of the terrain, both for the quality of the textures and due to the design of how the progression of the Vr experience and points of interest would become.

3.4 Terrain

When beginning the development of the island, the 3D structure of the terrain of the island was determined. Utilizing the Terrain sample asset pack, there were more than enough modeling tools to help create rocklike textures within both lowered and elevated surfaces. This includes different-sized mountains, replicated rock formations in specific places of the VR experience, and smooth green landscapes with a variety of subtle heightmaps. The distinct open landscapes were made to replicate those that are found in forest treks, at least those in Madeira. These include replicating the open spaces of cliff walks on elevated spaces, the distance between the mountains that surround the paths, getting a good view from said mountains, and having a soothing sound when near these specific places and others such as rivers.

Due to an issue with creating these landscapes, because of the low polygon count, the island was recreated with about 10 times the polygon count for better detail. This large leap in polygon count was a means to test the capabilities of the engine. As expected, due to this, the higher polygon count started to decrease the framerate of the experience, forcing the polygon count for certain heightmaps to be lowered since many of them were located far from where the player could go to look at the details. Adding to this, since the areas where the player would go still needed to have higher quality, their "detail distance" feature was decreased, which means that the polygon count decreases depending on where the player is. As this problem was handled, framerates increased to a

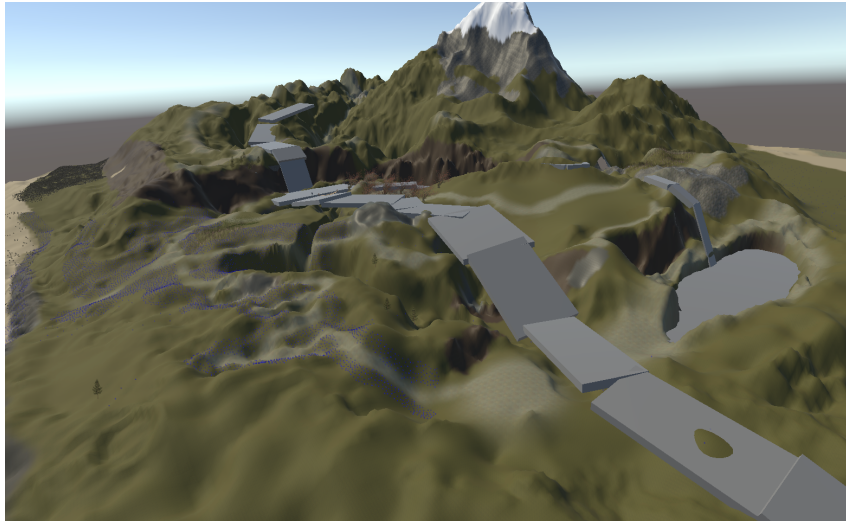


Fig. 10. The first attempt on creating the VR experience, with certain mappings to experiment and decide the final looks

stable amount, even nearing 90 frames per second. However, another problem appeared soon after. The auto-connect feature was turned off when searching to further improve the landscape quality, before knowing that it connected the group of terrains. The heightmaps changed their identity, which made them detach one from another. This means that changing their height would result in only one of them changing form instead of if both were attached. This creates holes below these heightmaps. The answer to this issue was in the terrain settings section in the terrain inspection tab, in a section called "grouping ID", which defined which groups of heightmaps were attached to one another.

The mountain structure, while simple in concept, has required multiple remakes to make it look more realistic. While the textures are used to represent the specific visuals for where they are placed, the use of decreased opacity helped mix multiple textures to create a more authentic rock look which added to the terrain shape visual of the mountain. However, it turned out that not only it did not look just right regardless of the choice of texture, but it always stretched the textures in a way that elongated things like cracks, thus looking wrong and pixelated. A quick method to solve this would be using UV mapping/scaling. Ultimately, while searching for ways to make them look correct, unaware of the UV mapping/scaling method, it was decided to use the "set height" tool to make random surfaces all around the mountains in random spots to give it a straight rocky look, added with a quick smooth touch so it looks more realistic. The path where the player would go frequently utilized this tool so that the player would not be constantly jolting up and down as they walked the sand path. The rest of the textures were mostly a variation of different rock ones with a mixture of many grass types on the top of the surfaces so that it replicates the rough inconsistent look of mountains.

As the creation of the VR experience went on and the details and pathways were finished, playtests began, although without the VR headset at first. A plug-in for Unity called "Game Creator 2", made by Catsoft Works, was used to aid development for this project for things such as making events so to activate or deactivate sections of the game and for adding the player model and controls in early testing. This was used in past projects and was proven to be helpful here

again for similar reasons, amongst which playtesting the VR experience to evaluate its terrain, item, construction placement, and general progression by writing down notes of the potential flaws.

3.5 Vegetation



Fig. 11. Example of quality diminishment of the vegetation due to distance

After the terrain was made, the environment was filled with plants. It was necessary for it to feel more alive and believable, but also to map out and bring focus to landmarks and structures. The trees are important as other means to guide the player and give them focus on the points of interest around the map, so that they can take their time looking at the landmarks. Because the trees are all over the VR experience they surround the player to give an illusion of depth within the island and help the player focus on the path and its properties.

Unfortunately, not only would inserting the tree models from the asset file straight into the terrain of the VR experience be time-consuming, but due to the potential issues that may come from compatibility inconsistency, it would also drop the frame rate significantly. That is why the terrain feature "paint trees" was used. While it still places the models that the developer chooses in the terrain, there was no need to level the altitude to parallel the terrain or to keep track of whether all models followed the right size. With it, it becomes easier to add a large number of trees or whichever model is chosen throughout the terrains as if they were painted on them. Adding to this, the number of models per click, which is designated as "density", can be defined, alongside the size area of the "brush". Although this helps with the framerate, it still adds the same models. Even if there is a way to decrease the polygon count in these models, if there are too many of them, it still lowers the framerate due to the number needed to replicate the forest of the VR experience. Because of this, there is a feature called billboard, which defines the distance the player needs to be for the terrain-inserted models to change into 2D images (see figure 11). However, it would follow along with their movement since they face the player, although it was not an issue unless players focused too much on it. Even if the trees need to be 3D in a certain area, their quality in textures and polygons could be reduced further.

However, this billboard system only takes into account the tree models. The other vegetation, such as grass, bushes, or flowers, would change their models entirely instead and at times their color. This issue is probably due to the configurations of the LoD systems in these assets, thus not changing into a 2D image. While the issue was being fixed, their addition into the world must become limited since they require about as much processing power as the trees in the level, regardless of whether this problem was solved. When this was fixed, only the more visible ones used the model, while background forest plants were replaced with plant textures in the terrain.

3.6 Narrative

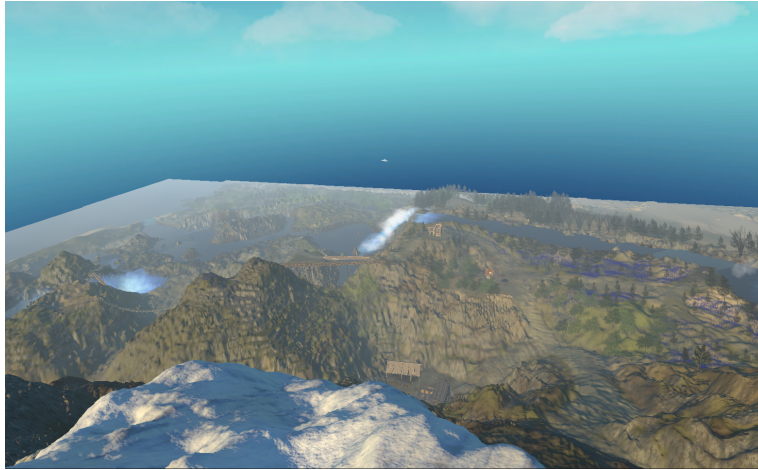


Fig. 12. The View from the top of the mountain, both for the player to take in their adventure and as a reward for playing through the experience

This subchapter focuses on the multiple iterations of the story as the development of the VR experience went on. The most distinct change in the writing was the jump from the first version to the one established in this subchapter. The narrative completely changed its shift of the experience from a psychological horror to a calm walking one, due to the former concept being too complex to be developed and polished within the time frame. However, the setting for the second story was already mostly settled in its first re-creation.

This first version of the calming VR experience depicted a storyline of a surviving castaway from a sinking ship who would wake up on the coast of an island. Realizing his situation, he reluctantly ventures towards the island and explores it, ultimately reaching up to the top of the tallest mountain to create a beacon so he can call for help, the view depicted in the figure above (see figure 12).

At this stage of the development, there was a narrative concept focusing on the mystery stemming from the structures placed throughout the level and their creator. In this iteration, the player arrives on this island after a plane crash, being placed on the beach by the waves. When the player regains consciousness, they notice a man with long hair and a long beard in a forest nearby telling them to follow them. After this cutscene, the objective of this version of the experience would begin. As the player went through the level, they would see and utilize the constructions on the island, but never see this figure ever again. When the player finally reaches the peak of the tallest mountain, it is revealed that the player character was the one who made all of it. The camera

dollies away from the eyes of the player to show the player model, who has longer hair and a beard with rotted clothing as he has been on this island for a very long time, even if time barely flew in the eyes of the player. The idea was to show that the player was responsible for creating every construction throughout the level, showing that they are capable of adapting themselves to any circumstance, including a scenario such as this. This story was heavily based on "Cast Away", the 2000 film directed by Robert Zemeckis, and the legend of Machim, a Madeirense local story that the name of the city of Machico was based on. However, while the message of this narrative was aimed to be satisfying and fulfilling, it still was not a relaxing story setting to be involved in. Because of this, the main narrative was changed to be less unsettling, having the castaway be part of a story which is expressed with the construction and illustrations he made across the island instead of the player, who arrives from a boat. There was still an interest in building the final narrative from it. There has been the idea that because the visitor character was this castaway, who survived this incident a long time ago, he has decided to return to the island to make peace with his past life, facing off his most feared moment in his life. In this concept idea, there would be figments of the "past self" of the player character as a sort of ghost figure throughout the level, reminding him of his experience in the past. These were conceived to help guide the paths of the level, being made of either transparent textures of the player model or particle effects, although attempting to create said idea quickly was proven to be too problematic to develop and be stable for the engine. This idea of facing the hard situation head-on as a means of dealing with trauma and having the character come to terms with his past has been explored in fictional media such as the Silent Hill games [33]. While not as direct with talking about this subject as the mentioned example, this story had the player character go through the island again as a means to deal with their mental trauma, going through the places in which they spent their time trying to survive on the island until help arrived. This story is still depicted in the illustrations at the first checkpoint of the game. This also reflects how the people mentioned in this article express how this game turned out to be more of a solace for their mental treatment, stating that the relatability of the mental state was comforting.

Another aspect that was necessary to be emphasized was to give the player the feeling of freedom due to the atmosphere of the open environment, with the same curious level design seen in games like "The Legend of Zelda: Breath of the Wild" [28]. This is to further encourage players to explore and want to see more of the environment visuals and worldbuilding within the level. The creations that are located throughout the level add to the element of exploration, since they all are things the protagonist made in order to survive, alongside being proof of what happened beyond the illustrations. In the end, however, this experience needed to be as short as possible, because of the potential health issues gathered from over usage of VR technologies that were stated in multiple articles [80], even if they do not involve user in scenarios with the same goal in mind, just in case. Regardless, the narrative needed to be decided in a way that would aid the immersion of the ambiance without breaking the believability and feeling of freedom these treks bring.

Soon after, the final version of the story came to fruition. It started with a quick slideshow presenting the setup for the adventure. The player character had decided to stop their boat near this island and then paddle towards its beach using a tender canoe. Reaching ashore, they would look at the tallest mountains on the island, which was the end goal of the level, before walking towards the starting point of the experience within the forest. This is so that the players could get used to the world environment before starting the gameplay, while knowing where they were and where they were going. The first section of the gameplay was purely to ease the player into the

biome of the island, focusing only on the tone of the sound and visuals of their surroundings. The plot would then be introduced at the end of either of these paths since they all would connect to a checkpoint.

Whether the player inspected the illustrations on the walls in the waterfall path or the hill area, the story of the castaway would be expressed through the constructions and items he made to survive and eventually leave the island. When that expository worldbuilding was shown, the player would finally reach the top of the mountain to look at the view of the level, having a flare shot from the person who was still in the main boat, signifying the end of the experience.

3.7 VR Experience Gameplay Storyboard



Fig. 13. The Visual interpretation for the experience of the volunteer

1. The VR experience begins with the introductory video of the game. In it, the player arrives at the beach of the island via tender canoe, where they are shown directly the final stop of the experience, the tip of the tallest mountain in the island. After establishing that, they walk toward the forest next to the beach, ending the introductory video.
2. As they finish watching the video, they are taught how to play the game, equip the VR headset and controllers, and adapt to the environment where the VR experiment begins.
3. The gameplay starts with the player in the middle of a crossroad within a forest, which is divided into three trails. All of them led to a sufficiently visible route, with a faint sound of what

it contained, to help the player choose where to go. From left to right, the paths were the waterfall that goes through the island is most pronounced, a ravine with wildlife, and one that led to the coast of the island. All of these paths contained man-made constructions such as bridges and tents.

4. Regardless of which path was chosen, they eventually find themselves at a checkpoint that connects all the former paths. In this area, an illustration could be found that reveals the background story of the castaway who built all the things on the island. The drawing ended within an angle that would show the end goal of the experience, the tallest mountain on the island.

5. The player would choose between one of three paths that led to both the home of this castaway and the water source of the island. One would lead through three hills connected with bridges, with the sounds of the valleys between the mountains, being an early teaser for the climb to the end of the level. If the player had issues with heights, they could also go through an alternative path found within the valley, which led them to the home of the castaway. If the player began to feel ill but could continue, they would be guided to the shortcut that led straight past both these paths.

6. Again, whichever path is chosen, the player would find themselves on a linear one that leads directly toward the endpoint of the experience, the tallest mountain. Climbing towards the top of it, they could see the items that were used by the castaway to make a beacon, alongside getting the chance to glance at the view of the level, showing the whole level the player went through. If they glance at the sea, a flare goes off from a boat for a few seconds, which eventually brings out "the end" text on the screen.

Figure 13 depicts visually the written steps.

3.8 3D Models and revampments

Countless assets of models, animations and plugins were made and given for free for years in the Unity Asset Store. They are important for helping with the creation of projects such as this one, which had a limited time frame. Before making the items that could not be found in the store that added to the level, the ones found needed to be put on the map to evaluate if their visuals belonged in the same world and narrative. After these were inserted, the missing items were then created. These included the signs that would help guide the player around the level.

Blender made modeling certain assets and new models easier. Besides modeling, there are also options for texturing, coloring, polygon count, animation, and shading. While this shows how difficult it may be to master the software, it brings attention to the problem with the insertion of certain models within the asset store, which are made within their structural designs that are rarely consistent with other chosen models. In these cases, there is always something that needs to be more visually consistent with the settings placed for the project. For example, some of the wooden models had a more cartoonish look to them due to the original texture design. Because of this, only some of them were placed at the level and had their textures changed to more appropriate ones if their model design made it look right in their context. There were also some problems with the shaders. A usual problem was the materials looking off due to the lighting reflection not working correctly. This was solved by changing it to another type of shader, preferably one that follows the render version of the Unity project, this being the Universal Render Pipeline (URP). This render version allows a greater variety of shaders to function in the level.

Some illustration programs were used to create textures in PNG format, such as Krita, which has functionalities found in some Adobe products while being easier to work with. These were either added throughout the level or replaced with the texture of other models to replicate how the illustrations were inserted in things such as what was on a billboard or hieroglyphic drawings in front of rock formations. Mapping a new illustration from a copy of a texture became an easier alternative when peculiar areas required a different look due to the context of the level design. While this is a quick method to take advantage of the textures of the game, texture projection is especially suggested for mapping in more complex shapes.

3.9 VR Controls

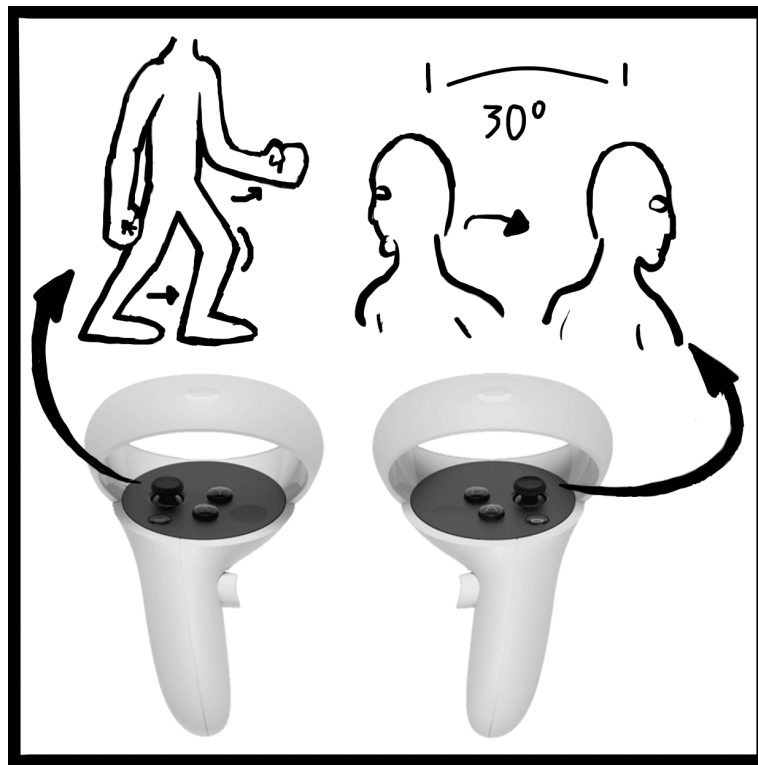


Fig. 14. Illustration of the controls of the game

The plug-in named Game Creator 2 (link to the page in appendix) has helped with the creation of the gameplay aspect, most notably with events and for testing the level before inserting the VR tools. It was useful as a tool for people who have less experience with programming, while still providing a similar logic for conveying the commands. Adding to this, all objects and assets can be given commands for things such as events or collisions in the added game creator menu. This editor can change things such as the movement speed of the player character or how fast they turn, models and animation, gameplay features, and the camera position.

The creation of this project was made in the latest "Long Term Support" version in Unity, which worked best with VR modules, this being the 2022.3.21f1 one. The necessary modules are those from the "Android build support" platform. Since this experience was played on a Windows computer, no other support modules were needed.

In this experience, due to its simplistic gameplay and needing to focus on being immersive, the VR controllers were chosen over the mouse and keyboard, in this case being those of the Meta Quest 2. We then followed the "Create with VR Course" in Unity Learns, which provides information for inserting into Unity and how to make the VR camera, colliders, and controllers work in the game.

After everything was set up and calibrated, the controls were tested. The gameplay of this experience only involved walking and looking around, both of which had two variations of how they would move in the level, alongside the button prompt and sensitivity. There is the continuous movement option, which has the player manually move with the selected analog stick, and the teleportation option, in which the player has to point where they want to go, with the added feature of restricted teleportation, which only allows the player to be in specific parts of the level that need to be marked in the editor. For the camera controls, there is continuous turning, which has the player smoothly look around the level, and snap turning, which jumps to another angle, both with the other analog stick. While some VR experiences do not include camera controls due to increasing the chances of users feeling unwell, this experience required having this since this experience had the player go through a controllable journey. Another reason for the optional camera and movement controls comes from the fact that the potential players may be physically handicapped, thus giving them an easier method to turn. What confidently assured this decision was the theme and intended game design of the experience, since many popular VR games put the player in much more intense situations with said controls. However, when considering the use of the camera controls, the effects it causes must be cautiously evaluated throughout the development.

As depicted in the figure 14, we choose to have the camera do a snap turn because the player can still angle their head around to look at the level as normal. Using the continuous camera turn to look around could potentially make the experience dizzying, as stated by some users that it makes them feel an "out-of-body" experience when playing, thus being nauseating. However, it was decided to make it so that the player would walk around continuously instead of teleporting for multiple reasons. It is usually encouraged to make a VR adventure experience in the latter method, but in this case, it was intended to replicate a trek in the woods experience, and walking by the elements and hearing them and the surroundings is a major part of the experience. Because of the shorter trek time, taking under 10 minutes to finish the game, which was calibrated as playtesters requested faster or slower movement speed, the potential issues that could arise were shortened, alongside the fact that this experience involves no scenarios that add motion beyond the animated views like waterfalls and wildlife. Because of the potential issues that may come with VR, such as nausea, the walking animation movement was cut from the game, so to lessen the probability of cybersickness. This discovery was considered when cutting the animated intro from the game for the same, although more apparent reasons. Most VR games that use teleportation let the player go anywhere on the maps, which in this case would not work due to players going through invisible walls into areas outside of the built level. Beyond taking away the intended purpose of this experiment, if the teleportation was made so the player could freely roam wherever they pleased, they could easily go to areas that were out of the experience, breaking immersion. Adding to this, because the environmental events activate when the player passes through the collider, teleporting past them would not do so unless they teleported in the right spot, ruining the experience. In the development phase, it was unclear how to make the collider work in the space where it was placed, only working when touching the borders, hence this outcome. There is the option to assign certain teleportation spots throughout the level, which would make the intended experience more controlled while providing a better movement option for a general audience. The problem with this

stems to the concept of immersion in the experience, which would be taken away if the idea of going through a trek in the woods did not involve walking in more specific areas, taking away some of the sense of freedom and exploration that treks in the woods provide. While the experience is supposed to be linear with its paths, the way that players reach the points of interest adds to the experience. When moving from one place to another, the player can feel and listen to the sources as they get close to them, essentially being able to immerse in the linear intensification of visuals and sound, something that teleportation abruptly cuts, taking away a major quality and purpose of the experience.

While talking about the project settings, the best version to use to help make games that utilize external tools that are not mouse or keyboard, such as the VR headset and its controls work. This was a major reason for the choice of the engine, which was noted when deciding which engine to develop the experience in.

3.10 Animation



Fig. 15. A wolf within the wild looking around, to fill the atmosphere and bring life to the scene

While still a notably time-consuming stage of the development compared to creating and placing assets, for example, animations were less problematic than expected. Having wildlife and vegetation merely placed alongside the terrain, still water, lighting, and construction were not enough to bring the world to life, because most of the elements mentioned were static. This is why it was important to animate key elements within the level, such as the water flowing through rivers, the vegetation shaking due to the wind, and animals doing things in the environment, so there is more for the player to immerse themselves in. Thankfully, within the chosen wildlife assets, there were animations implemented alongside the models, such as the wolf shown in the figure 15, which was made by Dzengames. Of course, even in these cases, these needed some tinkering so that some of the animations that these models would do would be appropriate to the specific action depending on their scenarios. Furthermore, their animations needed to be made so that their transition to other animations would look right, or when they looped their own in a way that it looked natural and thus be played for longer, for cases such as the idle state. Unfortunately, many animal assets were removed from the game due to their inclusion decreasing the framerate.

The waterfall and rivers were animated differently. It was made using particle effects, which spawn many images of choice that spawn out of a spot in whichever way or route the developer chooses, which in this case recreates the scattered flow of the waterfall. The added splash effects used the same method for the sprinkled water flying outwards as the water splashes when reaching the bottom, and the currents were made from either the splash or the flowing water. This made a visually appealing waterfall that did not decrease framerate while providing a visual spectacle within the experiment.

At first, both the introduction and conclusion were made into animations using the timeline and animation windows in Unity, which helped to define the position, angles, and sizes of the models for each frame. As previously mentioned, at one stage of the development of the VR experience, there were going to be apparitions within gameplay to show past events before the arrival of the player, which would also guide them around the level. Ultimately, this idea was scrapped due to time restraints. Besides, the story of the world was better found out from intuitive exploration derived from the worldbuilding of the level, such as stated in games with open world exploration [27]. After scrapping this idea, an animated intro and conclusion were made for the VR experience, which helped the player settle into the environment. The intro started with the player rowing on a boat towards shore, looking back at the boat from which they came and then at the tallest mountain on the island. They then walked towards the forest, fading in and out to where the level would start. If the VR experience just started in the forest without visual or narrative context, not only would the player be more confused about how they got there, but they would not be prepared emotionally for what was to come from the adventure, since they did not get used with the tone of the environment before having to choose paths. However, this had to be changed into a non-VR 2D slideshow representation of what would have been the introduction instead of a full-fledged VR video. Since this was a cutscene, it was designed to be seen without intervention from the player unless they wanted to skip it. This means that it forced the player to look at what the camera was pointing at, regardless of how they were moving their headsets, meaning that the only movement that was made came from the camera and what was animated. This meant that when the VR experience started, the player would have an out-of-body experience due to the camera following movement that is not their own, including the protagonist rowing the tender canoe, leaving the players nauseous. Ultimately, the animated conclusion was scrapped, and certain shots were used to recreate the slideshow version of the introduction, alongside certain animations, such as when the flare was set off from the boat to signal the conclusion of the experience.

3.11 Sound and music

Because of the setting and intention of this experience, it was important to utilize a multitude of ambiance sounds, replicating audio from a real walk in the woods. In the case of this experience, the focus is on the peacefulness of the environment and its elements that contrast with the noise pollution of the cities. Surround sound must be utilised to simulate this effect, such as how meditative exercises and other VR experiences help listeners to focus on the relaxation within their chosen methods.

The most important sound effects included in this experiment are of the water flowing from the beaches, waterfalls, and rivers, the wind blowing from the top of the hills, the trees moving, and the wildlife roaming around parts of the level. Because of the number of sound sources around the level and due to the opportunities to be surrounded by the sound they emit, such as when getting

near a waterfall, the mixture of sound effects creates a surround sound where the player is located. This surrounding of soothing sounds have been shown to be efficient in other articles, this one utilizing ones from a river source to influence listeners nearby [14]. Adding to this effect, surround sound was an easier yet subtle method to help the player choose which path they chose to take at the start of the level, alongside understanding what surrounded them as they went along. Because of this, the players could also anticipate what was to come from the experience, in case they could not go to a specific path, for whatever reason, and want to go to one that appeals to them the most.

3.12 Testing the level



Fig. 16. Screenshot of third person playtesting, to evaluate the progression of the level

After creating the level, the moment to test the created experience arrived, including how long it would last. Going through all spots of the level, the early tests gathered an 8:02 run time, with little to no looking around. Although many articles have shown that VR is safe to use for under an hour length of time, these examples are in cases of younger users [93]. For an experience intended for anyone, it is safer to make a shorter experience so as to decrease the likelihood of users being affected by dizziness and cybersickness. Because of how long it took for the experiment to be finished, parts of the level had to be removed.

At first, the swamp and canyon sections were removed. Because they served no purpose but to transition to the next section, and they did not have anything as captivating as the other sections, they barely stood out. Alongside this removal, the player now spawns directly on the three-choice path in the forest instead of walking around on a beach for over a minute, which, in tests of the level revealed to take too long in general.

The first tests were made without VR equipment since it was necessary to know if the basic structure of the level had any problems that hindered the experience and thus needed polishing (see figure 16). In these tests, there was a need to understand if the way the pathway looked was ideal as well. This included if the visuals were appealing, the way the section would be revealed as the player approached it, and the way that it would show the panoramic views depending on the progression of the player, which would also show the optional routes that the player could choose before reaching the checkpoints. These depended on how the elements were placed throughout the

level, which would help intensify the visuals of the natural points of interest across all sections of the level, such as the main waterfall. Adding to this, a lot of them had sound sources that not only needed to be placed accordingly but also needed to have the right volume and audio pitch. These needed to be dispersed enough so that the player could hear them when they were in places such as the crossroads and throughout the routes they chose, so that they could hear the others as well.

After many tests and fixes of the level, we began testing the level with the Meta Quest 2 connected to the computer so we could get used to it and its controllers. When enough of the VR experience was developed, gameplay with the headset was implemented from the other "Create with VR Course" scene, replacing the settings from previous tests, with the decided VR controls after some early experimenting. Due to an unidentified error, the experiment could not be played through the headset in itself, it needed to be connected and open in the computer. Beyond testing this, walking around the level with this made it easier to tell the smaller inconsistent elevations that were not noticed outside of VR. It was necessary to find as many nooks and crannies as possible so that the player would not stumble on any of them and feel nauseous.

Plenty of tests and calibrations were made to improve the performance of the program. The people who volunteered to test the early versions of the VR experiment were sometimes confused about where to go in the linear paths, mostly due to the ascending sections of the level. Because of this, later versions of the path were illustrated more distinctly, especially in these harder-to-follow sections. These early tests revealed that certain aspects of the level that were visually worse were placed in a way that the quality drop was not noticed, such as the billboards of the trees. Because these sacrifices for performance did not tamper with the experience, it created slightly faster runs, overall making the experience last between 6 minutes to under 10. The difference between these time periods depends on whether the player takes their time to look around or goes to the longest routes to finish or not.

4 Evaluation

This chapter establishes the evaluation of our VR experiment; it starts by describing the hypothesis and research questions that guided the protocol, measures, and then finally describes the results obtained. While this experience measured how the players reacted throughout their session and was made to help the relaxation and immersion, the account of which variable inside the VR level was not taken into consideration. However, while it is important to acknowledge that this experience required one session, meaning that there was no different version for the volunteers, some of them did not notice the story told from the Worldbuilding, even if it was stated that the thesis involves it. This fact was asserted in the qualitative questions, which focused on Worldbuilding.

4.1 Hypothesis and question

The rampant technological advancements have opened up new views in the field of virtual reality, allowing the opportunity to simulate aspects of real-world activities and environments, combining them to create entirely original worlds based on them, with a focus on creating a stimulating sequence. However, this led to contemplation over the extent of its effect, comparatively, when these virtual simulations of real life experiences were hindered for certain reasons. The allure and pleasure of exploring the wilderness or open spaces, such as beaches, where one can relish the sensory experiences without being overwhelmed, is critical for fostering good health [15]. The pertinent question was the efficacy of virtual reality recreating these sorts of environments with a comparable stress-relieving effect.

The hypothesis, according to the information gathered in the state of the art, derives from the acknowledged technological advances. Because of the many sensory immersive tools such as the VR headset and controllers and simulated examples of how both real and fictional elements, those based off of nature and those created by man, respectively, can captivate countless individuals, the culmination of these can create a more effective tool for relaxation for people who cannot go to said place for whatever reason. For the general populace, the limitations gathered from the COVID-19 pandemic have caused them to have to adapt to the unique scenario [94]. Since they were forced to stay at home, they had to limit their choice of activities, especially those most accustomed to outside activities, such as the stimuli gathered from walks or in socializing in person, for example [4]. Because of this, people use technology more often for work, to meet people, or to pass the time as a means to endure staying at home for a prolonged time [3]. All of this brought attention to how certain people from before and after the pandemic have adapted to continue to utilize said technology for the same reasons. Beyond this and the now further intensified work due to companies learning the advantages of working at home for certain occupations such as desk jobs, some people either suffered physically from direct contact with the virus, mentally with the restrictions caused by the quarantine [94] or already had some physical restraints, such as if they are wheelchair bound.

At the start of the writing of this thesis, the idea for the hypothesis was taking its shape. Although the game was focused on a dream-like experience at the start, it was always the point to immerse the user in a relieving story about acceptance, which, while still helping remove tension, did not focus inherently on relaxing the user the same way as this experience does.

The focus of the thesis and the purpose were then polished throughout the research, ultimately focusing on the following criteria:

1. How much can Worldbuilding help immerse the player within a VR experience intended for relaxation?
2. How does the culmination of Worldbuilding, Elements of Nature, and VR, affect the overall experience?

4.2 Protocol

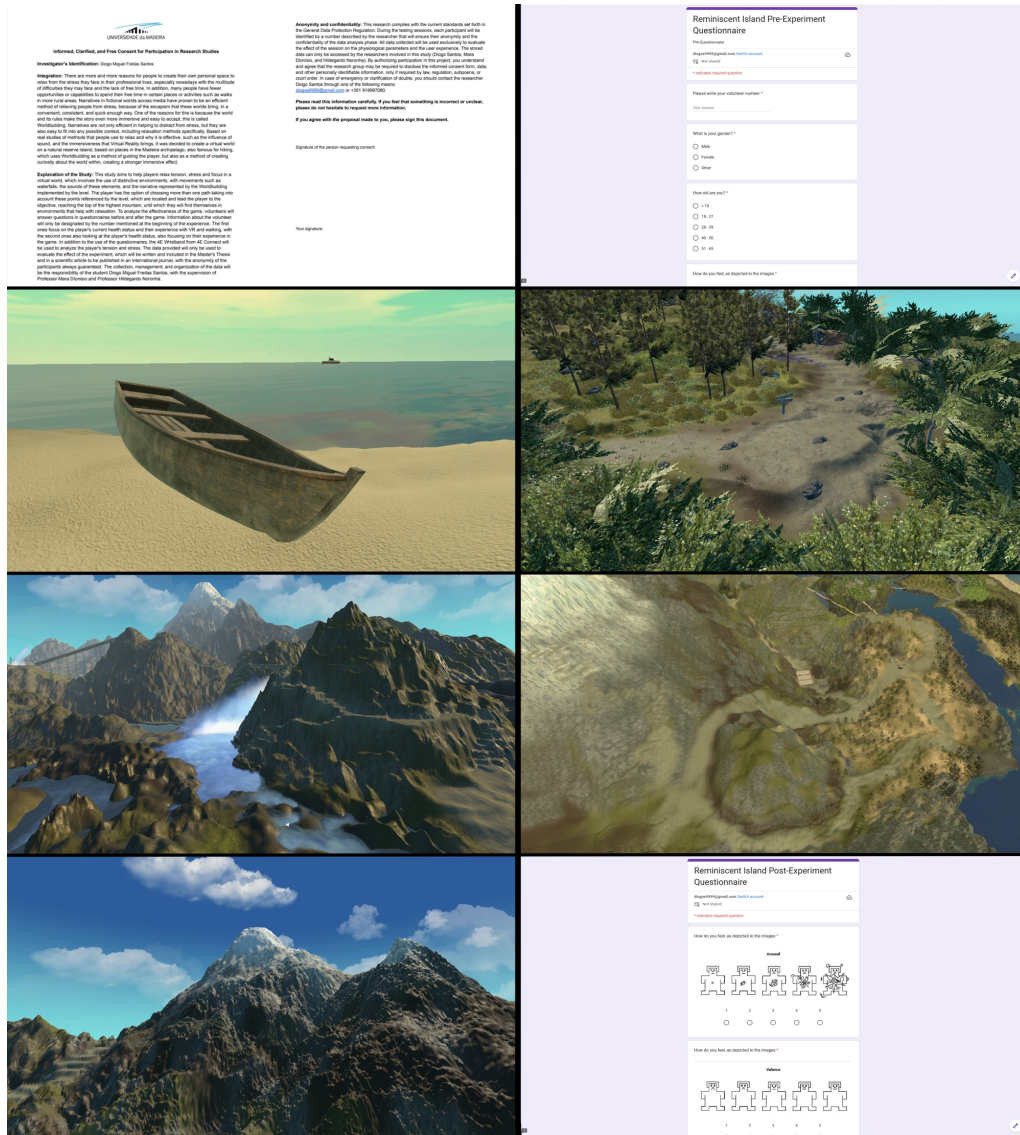


Fig. 17. The Visual storyboard for the experience of the volunteer

The following list is of the steps the volunteer did for the course of the experiment (they are illustrated in the 17 figure):

- 1 - The volunteer reads the consent document, which contains information about the concept, the goal of the game, and the potential side effects. Then they sign it
- 2 - The player would be given the E4 Wristband so it was to be set up before the start of the gameplay.

3 - Meanwhile, they began to answer the Pre-Experience questionnaires.

4 - They then would watch the introduction video contextualizing the place the player would be for the duration of the experiment, as well as pointing out its end goal. In the meantime, the researchers closed all outside sound sources to help the volunteer be immersed in the experience.

5 - The researchers gave the volunteer the VR headset and controls while opening the build.

6 - The researchers teach the player how to play, remind them of the goal of the experience, and after setting up the first timestamp in the wristband, let them play.

7 - as the player explores the virtual world, the researchers write down notable reactions they see the volunteer do, as well as guiding them in case they need assistance.

8 - After beating the game, the volunteer would then take a breather if needed due to the potential side effects of the experience. When they show that they are feeling well, they would then answer the Post-questionnaires.

9 - They then give their final words about the experience, the researchers would remove the wristband from the volunteer and thank them for their time.

10 - After they leave, the researchers rounds up the results in a folder designated by the volunteer number. This would repeat until enough data was gathered for the analysis of the results.

4.3 Inclusion Criteria

The target audience for this study is adults from any background, since this experience is for as many people as possible. For the sake of precautions from VR intolerance, health issues or imperfections within the experience, it was decided that the volunteers were all between the ages of 18 to 65 years. While prior experience with either VR or walks in the woods is not required, the Pre-questionnaires measure how much the users have for both of these. Furthermore, this experience was designed so that the potential players who are paraplegic people are still able to play, as well as people with mental health issues such as depression. Even so, there needs to be caution due to the potential side effects of VR. It was not necessary to conclude the entirety of the experience if certain volunteers felt incapable of doing so due to symptoms such as dizziness or vertiginous syndrome [80,81].

As seen in the graph (see figure 8), the level has been designed to have multiple choice paths, to make the experience feel more open for the players. This is important to help them pick the path that fits them best, as well as if one of them has a phobia, such as a fear of heights. This also helps to make the experience replayable, so it is easier to feel the same experience in return. Furthermore, it helps when this experience needs to be shorter due to any reason, whether is time restrains or dizziness.

4.4 Measures

Eventually, we requested volunteers in a space of two weeks for the experience. Each of them was involved in one session, because this experience was evaluated with questionnaires before and after it, aiming to measure the first impressions of it. To measure the experience, we used a multitude of methods alongside those mentioned in the chapters of the State of the art, such as the article by Matilda Annerstedt et al. [15] and those made by Giuseppe Riva and Daniela



Fig. 18. The Visual storyboard for the experience of the researchers

Villani [17, 25] to ensure the results of the experience and how it added to the relaxation of the users. This included notes from observations of the gameplay of the volunteers, the results from the heartbeat measuring wristband, and Pre and Post Questionnaires, which were inserted in Google Forms. In the search for models to use in the questionnaires, the PXI, short for Player Experience Inventory [95] and the PQ, short for Presence Questionnaire [96] were considered. PXI is a direct method of evaluating real-time responses to the design choices of a videogame and showing "second-order emotional experiences", describing the Functional Consequences and Psychological Consequences respectively [95]. The Presence Questionnaire resembles PXI to a certain degree, though it measures the game flow of the experience of the player with a questionnaire made following the experiment. It focuses on the factors of immersion, sensory fidelity, involvement, and interface quality [96].

While the PXI and especially PQ have been shown to be efficient methods of studying the behavior of the volunteers within and outside of the experience, retrospectively, [95, 97] they do not specifically focus on the emotion of the users and instead on their comprehension of the subjects at hand. The three options mentioned ahead followed the referenced criteria. The SAM, short for Self-Assessment Manikin [98], is a method that focuses on the analysis of non-verbal ways to convey emotional and affection responses from users to visuals, such as looking at the panorama. In the article provided by Dini Handayani et al. [98], the experiment focuses on analyzing the reactions of people when they see video clips, utilizing SAM as a means to evaluate sadness, happiness, anger and fear. Just like this experience, the results were rated with valence and arousal. The AD-ACL, short for Activation-Deactivation Adjective Check List [99], is a method that studies a multitude of emotional responses from users, expressed through four categories that reflect their state after the experiment compared to when they started [99]. Because neither of these analysis models focuses on the gameplay aspect of the experience, the addition of the PENS, short for Player Experience of Needs and Satisfaction [100], was used to answer these questions, alongside those of sense of freedom and immersion within the virtual world. These models were inserted in both Pre and Post questionnaires, with the exception of the PENS, which is only in the last. Besides these models, there will be questions that focus on the age, gender, and how experienced were the volunteers on either VR technology or trek in the woods in the Pre-questionnaire. Afterwards, in the Post-questionnaire, there were qualitative questions focusing on their experience with the game, such as how they felt in peculiar instances, and if they knew what the story was about. This would give a detailed idea of how their experience of the game went, according to the players, ultimately helping to understand if the objective was fulfilled.

Even if the player was given these questionnaires to express themselves and compare their thoughts on the concept of the experiment before and after, there was a need for a method that made these statements more accurate as they were noted by the volunteers, instead of solely relying on the potential inaccuracy of the retrospective. Not only because they may have shown reluctance to express themselves accurately but also because they just cannot remember entirely how they felt at that moment.

There was the idea of using any sort of recording device to see when a player reacts to things happening in the experiment, either with a camera or with a screen-capturing recording application. However the legal implications would have to be taken into account, and to have the license to do this method of testing would have required a large amount of research, when simply noting the event in person would suffice. Ultimately, the use of a heart rate measurement tool was decided

to be the best way to solve this situation. The E4 Wristband by E4 Connect was chosen, due to it having more than one measurement relating to stimuli. It analyses 5 physiological data through its sensors: EDA (Electrodermal activity), BVP (Biventricular pacing), Accelerometers, HR(heart rate) from IBI (Interbeat interval), BPM ((heart) beats per minute) and temperature in Celsius.

The user had to hold on to the wristband button for a few moments until a blue light appeared so the activation process began. Even if there needed to be readjustments or need to tighten the wristband so it read the results with better accuracy, the volunteers felt comfortable. As soon as the synchronization between the app and the E4 is connected, the wristband starts to read the blood flow of its user. However, it was safer to wait approximately 40 seconds as a precaution in case the wristband moved around enough and lost accuracy. In case this happens, the researchers would adjust or tighten the wristband until the graphs shown in the app looked right and showed accurate readings. To assign the instance of the events throughout the experience the button of the wristband must be pressed while it is still reading so it is easier to compare the state of the user from before to after the VR gameplay. To end the data collection, the button must be pressed and held for 2 seconds. After this, the data collected is transferred to the E4 connect site on the sessions page, where the researchers can retrieve and see the five graphs representing the physiological data, alongside downloadable Excel files that show a more detailed representation of the results. We noted extra details about the results as they spectated the game on the computer screen, evaluating notable events of what the volunteer did in the game and guiding it if needed. These results were also saved in the result folders of each volunteer alongside the ones from Google Forms and the Wristband. the volunteers were identified only by their number.

4.5 Data Analysis

The results of both the Pre and Post questionnaire were then taken from Google Sheets, placed in folders that were named after the volunteer numbers, and then calculated and analyzed, respectively. The Quantitative data has the results of the SAM, AD-ACL, and PENS from the questionnaire models and the IBA and EDA from the E4 Wristband. This includes results such as their mean and the Standard Deviation. In total, there were 30 volunteers for this experience, of which 18 were male and 12 were female. Of these 63.33% were between the ages of 18 to 30, with the other bigger value of 50 to 65 year olds with 16.7%. 86.67% of the volunteers had some experience with VR, with 26.67% having deep experience with it. 16.67% of the volunteers have no experience with treks in the woods and 56.67% frequently go to them. The Qualitative data does not show these calculations for certain questions, such as for questions that have the volunteers reflect on their experience with VR or their difficulty traversing through the level. The E4 Wristband from Connect E4 was used to evaluate psychological responses to the experiment as opposed to potentially inaccurate retrospective answers from the volunteers. Both the questionnaires and the Wristband results were then analyzed using the JASP program, which was utilized to run the statistical tests. Because the questionnaires are both multiple-choice answers and have questions categorized on consistent parameters, they were tested using the Wilcoxon signed-rank test. Because most quantitative results are measured before and after the experience, they use the Paired Samples T-Test with a different alternative hypothesis, with the exception of PENS and SDNN, with only their means and standard deviations being accounted for. The Wristband measurement results were tested using the Student t-test. Of the 5 physiological data results, only 2 were used for analyzing stress and tension, these being IBI and EDA. Otherwise, they are useful as notes to further define their experience and help improve the design of this experiment and future projects.

4.6 Quantitative Data Results

This chapter focuses on the data gathered from the answers given by the volunteers in the Pre and Post-Questionnaires, specifically the ones that analyzed their object reflection on the experience they have gone through. The more detailed results are shown in the tables and graphs, which are placed in the appendix chapter at the end alongside the detailed results of the E4 Wristband. These questions were the following questionnaire methods.

4.6.1 Self Assessment Manikin

In normal circumstances, this questionnaire method uses 3 pictograms to define the feelings of the users in the Pre and Post questionnaires, so as to compare the effect of the VR experience. These are Arousal, valence, and Domination [98]. The latter of these was not used in this experiment, since it does not fit with the intended purpose of the experiment. The results show an increase in both, however, it is much more significant in Arousal than in Valence. According to Dini Handayani et al. [98], the SAM Arousal and Valence scores represent four emotional states depending on if both, either or neither have a higher or lower value than average, which in the case of this experiment is the value of 3. In essence, "happy" is when Valance is below average and Arousal is above, "calm" is when Valance is above average and Arousal is below, "sad" is when Valance is above average and Arousal is above, and "fear" is when Valance is below average and Arousal is below. Because there were 30 volunteers, the mean results are 30 times the value established in the article by Handauani, meaning that the average result becomes 45.

The Wilcoxon Test V results for Arousal and Valence, respectively, are 61.5 and 39, with p-values of 0.028 and 0.644. The z value for Arousal is -2.110, and its Rank-Biserial Correlation result is -0.514.

4.6.2 Activation-Deactivation Adjective Check List

This model was evaluated utilizing a Checkbox grid, showing all 20 adjectives vertically and the 4 values horizontally [99]. The latter are "Definitely feel", "Feel slightly", "Cannot decide", and "Definitely do not feel", with the respective values of 4 to 1 to define the results. These values are answered depending on how the volunteer feels depending on the respective adjectives shown by the model. The values measure the 4 AD-ACL adjective categories, of which contain 5 more adjectives that are related to the said category, summing the total of 20 adjectives. Because the lowest score possible is one in each of the 5 adjectives, the score for every category is between 5 to 20, meaning that the average score is, as stated in the article of Orszaghova, 14 total. In the results of each of the 4 categories, all mean values surpassed the average value, but only tiredness showed a significant amount of decrease in value.

The Wilcoxon test results were the following: for Energy was $W = 232.5$, $p\text{-value} = 1.0$; for Tiredness was $W = 377.0$, $p\text{-value} = <0.001$ and $z\text{-value} = 3.449$ with a decrease of mean by 0.406 and decrease of SD by 0.072; for Calmness was $W = 191.0$, $p\text{-value} = 0.449$; and for Tension was $W = 92.5$, $p\text{-value} = 0.276$. The result of the Rank-Biserial Correlation was 0.03 for Tiredness.

4.6.3 Player Experience of Needs and Satisfaction

Unlike the other quantitative questionnaires, PENS focuses more on the gameplay aspect of the experience, having categories focusing on the immersion gathered by the player on the experience [100]. This questionnaire involves 5 scales with a total of 21 questions. 4 of these scales contain 3 questions these being Competence, Autonomy, Intuitive Controls, and Relatedness. The latter category was not used for this experiment due to its questions not corresponding with the events of the VR experience. The remaining 9 questions belong to the Presence/Immersion scale. Each of these questions has a scoring system from 1 to 7. While some of these questions reverse the scale value, the calculations had this in mind, keeping the worth of the values consistent. The following results are the mean value of the answer scores in each category, with the minimum being 3 and the maximum being 21, making the average mean score 12. Because this was only measured after the volunteer finished the VR experiment, it does not have z-values, since it is used to compare the results between. The mean of the PENS scales was 14.633 for competence, 14.767 for Autonomy, 41.100 for Presence/Immersion, and 18.167 for Intuitive Controls. The SD results were 4.672 for competence, 4.150 for Autonomy, 12.007 for Presence/Immersion, and 3.384 for Intuitive Controls. Because the Presence/Immersion scale results were three times larger than the others due to having just as many more questions, the results mentioned in the discussion will be divided accordingly to align with the other results. Because all results are above the average, the experience shows to have an overall appealing gameplay with majority approval in all categories, especially in intuitive controls, although its standard deviation is the biggest amongst the categories.

4.6.4 E4 Wristband data

The wristband results were another method to obtain more precise results for the experiment, in case of unclear results from the questionnaires. While this tool gives a recreation of the 5

physiological data measurement categories, for this experience, only 2 of them were necessary to measure stress and tension, those being IBI and EDA, respectively.

4.6.5 Interbeat interval

The three IBI measurements gathered from the results of the experience are the Heart Rate, the standard Deviation of Normal-to-Normal interbeat intervals (SDNN), and the Root Mean Square of Successive Differences (RMSSD). [26, 101, 102].

4.6.6 Standard Deviation of Normal-to-Normal interbeat intervals

The standard deviation of the IBI of normal sinus beats is measured in ms [102]. The SDNN removes abnormal beats, like ectopic beats, from its analysis. The mean value represents the average overall time it took for both heartbeats to take amongst all the volunteers. The mean difference of the SDNN value was 0.073 s between heartbeats (73 ms) (SD = 0.027). Because the unhealthy value is below 50ms and a healthy value is above 100ms, the average volunteer is considered more in the compromised kind of healthy, meaning that there was little SDNN effect on the volunteers, meaning that according to these results, the stress levels of the volunteers were not notably affected. However, due to the SD represented and the result of the questionnaire, these results are not consistent for all volunteers.

4.6.7 Root Mean Square of Successive Differences

RMSSD measures are gathered by calculating each successive time difference between heartbeats in ms. They are then squared, averaged and given the square root so to find out their true RMSSD value. The mean value represents the amount of vagal activity in the Autonomic Nervous System of all the volunteers [102].

The mean difference of the RMSSD is 0.116 s between heartbeats (116 ms)(SD = 0.054) throughout the playthrough of the experience. According to the Standard deviation, the results are noticeable, but not enough for a meaningful change. In the context of this experience, while the SD values imply results that are not accurate, it shows that the volunteers were not stressed, following what the results from EDA state, although some moments of relaxation are witnessed [102].

4.6.8 Electrodermal Activity

The EDA results consist of three result measurements gathered from the experience, all of which were sampled at 4Hz. These results are for EDA, Skin Conductance Level (SCL) , and Skin Conductance Responses (SCR) [103].

4.6.9 Skin Conductance Level

The mean difference of the SCL results of the experiment is 15.159 ' μS ' (SD = 13.395). Because the value is positive, the experiment has caused arousal over relaxation. However, due to the high value of SD, these results are not reliable.

4.6.10 Skin Conductance Responses

With a sample rate equal to or above 0.1 Hz, which is the minimum value that captures arousal peaks in the reading [104]. The mean of the SCR peaks per minute for the volunteers throughout

the VR experience is 11,499 ' μ S' (SD = 7,327). This means that the experiment has caused arousal since it passes the 10 ' μ S' mark. However, due to the high value of the SD, these results are not reliable. During this measurement, 9 players had a low increase or decrease in peak value, while the rest had large increases in peaks.

4.7 Qualitative Data

There is still information that can be used to mark the stages that justify the changes of effects from the experience and proof of points mentioned in the quantitative analysis, both told and noticed by the volunteers and noted by the researchers. However, the more consistent and important notes were mostly mentioned in the Qualitative questionnaires throughout the Google Forms pages. Before and after playing the VR experience, questionnaires analyzed things such as their experience with VR and whether they often trek in the woods, the former having more affirmative responses. While some of these are not measurable, they help to determine the nature of the experience and help understand how they felt throughout, while acknowledging its limits.

The following are the more common answers to the qualitative post-questionnaires. When players reached the end goal of the game, 13 of them had no difficulty and 13 had some. They showed appreciation for the view, stating that it was nice, appealing, and amazing. While the path helped 19 out of 11 to guide them through the level, When it came to path incentive, they wanted to reach the top of the mountain, choose the path that felt right after evaluating them, or choose which looked like it would have more to explore in. Two-thirds of the players noticed the hidden story among the worldbuilding scattered throughout the level, and half of them had an idea of what had happened there. Whether they knew or were not aware of the story, they appreciated the added Worldbuilding within the gameplay, stating that it made the experience more appealing, relaxing, and encouraging to go through and explore. While they state many issues with the game, the most commonly stated being that it requires smoother gameplay and that it should have more wildlife or vegetation, most enjoyed the experience and considered it appealing, even if it felt like a surreal experience, mostly due to the out of body experience. 25 out of the 30 players recommended the game and 26 stated that it incentivized going on treks in the woods. To see the questionnaires directly, click on the following link:

https://docs.google.com/forms/d/1HWeuAdVnoGqh3IBXTiJa_5Le81JH_zzDGqgCwVvnNY/edit

5 Discussion

This study aimed to evaluate how much Worldbuilding could help immerse the player within a VR experience made to help them relax, as well as understand how the culmination of Worldbuilding, Elements of Nature, and VR affects the overall experience. Worldbuilding helps users feel more immersed and accept the rules of the narrative worlds [7]. There are a number of articles establishing a connection with nature as well as its ambiance, such as sound [15], visuals, time, and weather [6], of which the culmination creates an effect of relaxation. VR has been used in many fields to either help relieve tension so to focus on the activities [74], or to have users embark on scenarios which are made more immersive with the HMD, including those for relaxation purposes [2]. The culmination of the three, from gathered research, has shown potential to further the effect of immersion, which this experience aimed to replicate for those incapable of going on treks in the woods and to have an alternative option in said situation. The quantitative analysis offers varied results regarding the hypothesis and goals of the thesis.

The SAM results revealed an increase in value for Arousal, which is statistically significant, meaning that even if the p-value of Valence was significant, it would still suggest that the experience has increased the tension or stress. Following the logic of the article made by Dini Handayani et al. [98], if the Valence results were statistically significant because the average result of the Arousal is above average and the Valence is below the average, the results would indicate that volunteers felt fear. Regardless, according to these results, the experiment did not help relax, due to the mean of the Arousal results being above average, which would require the opposite result to obtain the "calm" emotional state.

For the AD-ACL, all p-values are too high to be statistically significant, except for tiredness, which is highly significant. Because the Wilcoxon value is also notably bigger in Tiredness, it means that the likelihood of it happening by chance is the lowest of the 4. The Z-value suggests that the mean value has increased 3,449 times compared to before the experiment. However, beyond removing tiredness, these results do not reveal if the experiment helped with relaxation, due to the high p-values in the other categories.

There is one PENS scale mean result that leans closer to the maximum value of 21. This maximum value derives from each question within the categories having a maximum score of 7, multiplied by the 3 questions in the scale. The Presence/Immersion scale, however, has a maximum value of 63, due to having nine questions. Despite this difference, with a mean of 13.7 and an SD value of 4.002, if divided by 3, the Presence/Immersion scale follows the same trend as the other categories, making it the lowest mean value. This means that there was a relatively lower effect in Presence and Immersion compared to Competence, Autonomy, and Intuitive Controls. Regardless, they surpass the average score of 10.5. However, it is important to note that these outcomes did not change the fact that the VR experience did not achieve its stress-relief goals, according to the answers of the volunteers.

While there were some programming inconsistencies and, according to some volunteers, certain design choices of the experiment were not as desirable as they could have been, the opinions gathered in the qualitative questions say that the VR experience was appealing. From the first moments of the experience, they mention that when they followed the sound and visuals, they were feeling more comfortable, although with some signs of dizziness as well. In the case of the worldbuilt narrative, although the story was not entirely understood or noticed amongst most

volunteers, the inclusion of context-sensitive constructions and items around the scenery elevated the VR experience. Volunteers considered it appealing to the point of driving them toward the objective of the VR experience, alongside giving the players a sense of curiosity, which had them note certain sections of the game beyond the start and finish for multiple reasons. Some of these reasons unfortunately involve the limitations of the program, VR headset, and controls, alongside overseen issues that could not be fixed due to the likelihood of the developer catching them. Even if there were noticeable issues, even in the cases when volunteers showed to have issues adapting to the experience, they still came out of the experience noting a wide variety of mostly optimistic points, due to the goal, incentive, conceptual design, level design and visual and audio design. While some were truly immersed, others reported discomfort, with a third responding that they felt some amount of negative physical sensations such as dizziness, half of which having to quit halfway through the experience.

While some were truly immersed, others reported discomfort due to optimization issues between the computer and the headset, adding to the potential issues brought by VR usage. Under a quarter of the users felt a notable level of dizziness, some of which had to stop the experience before completing it. This dizzying effect has also been noted with less concern by other players, although just as many with contradicting aspects to the dizzy have shown opposite results. Some volunteers were much older than the majority of those who felt ill, some surpassing the age of 60, and had absolutely no problem with both adapting to the controls and the VR headset, whilst not feeling dizzy in the slightest. They stated that they felt entirely relaxed and when given the check on the post-experience, they were doing very well. On the other side, people who either had great knowledge of using VR technology or at least worked a lot with computers were struggling to keep up with the VR experience. Even when having two instances where the goal of the game is explained before playing, they quickly forget and others feel too ill to beat the VR experience, even if most do not have illnesses such as vertiginous syndrome. These people did not surpass the age of 30, and they were healthy. This may be because of their occupation and the length of their shifts, making them tired from, in this case, using computers during the day before they volunteered, having some comparison to "Smart Working" [3]. However, some of these people with a desk job who were assigned early in the day did not have these issues, regardless of how few of them worked with VR equipment. Besides this minority, the remainder of the volunteers have shown the expected results.

The IBI results analysis shows additional context. While the HR decreased, the mean results of SDNN show a slightly below-average effect on the players, however, this decline is still too short to be of significant effect. It is implied that the results gathered from the RMSSD show a large improvement in the strength of the Autonomic Nervous system, which means the users felt healthier as they played through the experience. However, it is inclined that the users felt more immersed than relaxed due to the results of the EDA measurements.

Because the EDA variability mean difference result is negative, the experiment has caused arousal instead of relaxation. This was further expressed by the increased SCL and SCR results. The latter especially shows many signs of heightened peaks, measured at 0.1 Hz, which, if passed, means that in that instance the volunteer is not in a relaxed state. However, there were more notes gathered in the Qualitative questionnaires that state most players found the VR experience appealing. Because of this, these peaks cannot represent stress, therefore suggesting these moments are either arousal or excitement. However, while the SCL and SCR results imply the aforementioned

statements, it is important to note that they are not to be entirely relied on. There are many factors that contribute to the results, since things like sweat and cold can also result from the heat of the day and breezes that may sneak in the room, respectively.

5.1 Study limitation and future work



Fig. 19. The Gantt Chart made for the Thesis Proposal

Although the overall design of the study followed some steps of the Gantt Chart (see figure 19), certain steps, mostly technical ones, took longer than anticipated. Initially, the experience was envisioned to be a more emotionally driven one, still utilizing immersive visual and audio elements. However, due to time constraints, not only did it shrink, but it also was designed to have a more appealing theme, not only for it to be more approachable, but also as an attempt to avoid potential side effects of VR noted in other articles.

The use of the questionnaires and the wristband provided complementary perspectives on the results from the volunteers, but there were issues in interpreting the wristband data for a few of the volunteer results. This is particularly regarding calibration and its impact on the accuracy of the early results. Future studies should take into consideration the proper placement of the wristband since while it was designed with sports practice in mind, knowing the exact spot to measure is not as clear as it may seem. Furthermore, E4 Connect should include a more detailed guide for using the physiological data gathered on the site to ensure accurate analysis.

Technical limitations also played a significant role in the effectiveness of the VR experience. Because of the contents and size of the level of this VR experience, it has posed a challenge for us to find methods to not push the performance of the engine, which affected some of the quality and size of the immersiveness of the environment. Furthermore, the Meta Quest 2 headset model used in the experience, while accessible, eventually has shown a problem with connectivity, both in wireless and then wire connection. While it ultimately did not interfere with the experience of the volunteers, it could have been if the players did not have the option to turn with the controllers.

This experience could involve people with many kinds of health issues, which would mean their gameplay would have to be limited depending on their state [74, 87]. It is crucial to keep in mind that these potential individuals could have unexpected and undesired results, which would require us to keep a closer eye on their health beyond the stress evaluation intended for this experience. The questionnaire was designed to be easy and quick to answer while focusing on helping the users

relax with the topics provided in the qualitative questions, although the latter will be used as a means to help specify the overall results. In the potential case of enough appearances of volunteers with more notable mental or physical issues, it was advisable to note these specific players while analyzing the effects of the experiment among all volunteers. This approach can also help define the limits of this kind of experiment so to identify users that may have more difficulties in experiencing them. Just so users could be aware before the experiment began, they were given a document of consent explaining the concept and purpose of it in detail, alongside a direct mention that the information gathered would be used only for the analysis of the experiment. This document would warn the readers of the potential side effects of the experiment, so if they have health issues they could remind us of it, thus making their experience safer.

The focus is on providing an immersive and engaging experience, VR technology remains a valuable asset. The future direction of this project can either involve developing a fully immersive experience, potentially returning to the initial idea of a dream-like narrative, or continuing focus on relaxation but without relying on VR technology, instead leveraging visual and auditory elements in a more traditional format.

6 Conclusion

The goal of this research was to be accomplished by utilizing multiple methods to help individuals immerse themselves and feel relaxed in a fictional world. This was to be accomplished while narrating a story with only worldbuilt elements, replicating sensory effective elements from nature in the VR experience, and utilizing VR technology to its full potential, ultimately to try and understand if this culmination would affect the overall experience.

The experience that was made with the State of the Art into consideration, replicating them into visual representations of famous wildlife treks in the woods in Madeira and replicating their general tone, such as the structure and positioning of the mountains. While Unity made it possible to create this VR experience with the countless amount of elements that complete the world, it would have been difficult to play through it without some performance methods on the visual, audio, and level design. With this in mind, there was a basis on how to create the appealing and large landscape that was envisioned, even when the final concept design of the VR experience was not entirely defined.

The experiment has changed a lot since the beginning of its creation. Changing from a psychological horror experience to a leisure walk in a forest, from utilizing only visuals and then having sound being a big part of the experience. It went from utilizing more VR tools alongside the VR headset and controllers to only the two being used in the end, and having the plot starring the castaway changed so it was inserted within the Worldbuilt narrative of the VR experience. In the end, the goal of creating an experience that relieved stress and tension in an immersive autonomous virtual world was accomplished. The development process of the VR experience consistently had an open space with multiple paths that led to the same goal, and it was concluded in a way that reflected the imagined redesign of the intended product. Ultimately, the final state of the VR experiment reflected the imagined end product at the start of its creation. However some features had to be removed since their count pushed the limits of the engine and due to immersed issues, some of which had a problematic effect on the intended product.

However, the results gathered from the volunteers of this experience show that this was not as effective as hoped. From the conclusions based on mostly the qualitative analysis in response to said experience and the difference between the before and after results, it can be deduced that the addition of Worldbuilding, while not narratively noticed, added to the experience, even if it is not the sole focus. Users appreciated the environmental structures in the way they added to the world and aided their adventure. It helped them feel assured they were on the right path, even if sometimes they would backtrack to see structures from other paths. However, this virtual experience intended to help relieve stress and tension needed more development time, as shown in the "Prototype Design and Development" chapter. Even for an experience this short, the VR experience still required much polishing to both simulate aspects of the inspired natural ambiance and be molded so the paths are smooth for VR traversing. Beyond this, the odds of finding problems throughout the development of its creation, such as errors and polishing the level design, needed time to be solved. There is also a case for understanding why certain people are affected by VR technology and others are not, regardless of their experience and age. Regardless, according to the qualitative questionnaires, at least around half of the volunteers were fully immersed in the experience. As stated in the qualitative answers, the colors and scenery of the visuals combined with the sound placements helped make the experience more appealing to them, even if some of these volunteers still felt some dizziness as well. These results somewhat contradicted those of the EDA and the questionnaire models, in which the volunteers stated that this experience was more arousing than relaxing. This means that the arousal that was measured mostly represented their immersion in the experience since they still have stated its optimization issues. There was also the potential that there was an issue with the connection. Ultimately, according to plenty of volunteers, this experience could have been more relaxing without the inclusion of VR technology, even if the main problem seemed from the optimization of the build. Even if it was theorized why it happened, the results have no definitive reason why certain young long-time users could not play through the VR experience smoothly and why the opposite would happen with older people who never used VR technology.

Ultimately, this thesis managed to bring insights into what could be made within the limits of the used material, such as the Unity engine, the VR tools, the elements of relaxation, and the addition of worldbuilding to help further immerse the user into the experience, as intended initially. While the development reflected the desired visuals and level design from the start, the experience did not have the expected nor desired results when put into the hands of the volunteers. This not only brought inconsistent results but also brought new questions on the limits of the use of VR technology. How much of a factor does the age and experience with this technology have with VR symptoms, and are there other less obvious aspects that need to be kept into consideration? This is beyond the situations that these individuals may have gone through before the experiment and the health problems that they may have which make it harder for them to play through the VR experience. Examples of this latter factor are the volunteers with a background that does not involve computer experience and or are overworked, and it is worsened if they suffer from something such as vertiginous syndrome. The older and inexperienced played through the VR experience and managed to feel relaxed, something that some of the other volunteers with more experience and knowledge on the subject did not. It might help to understand these limits by having players go through the experiment with versions that do and do not include the VR headset, so as to compare, or potentially use other XR tools.

There is also the thought of changing the genre of this experience while still following the same intended goal of utilizing worldbuilding as the narrative approach to ultimately help players relax. As mentioned at the start of the conclusion, the VR experience was originally made to be a psychological horror experience to relieve the player just like the narratives mentioned in the State of the Art. While these are not calming in concept, the execution of especially the former has shown to make certain users more at ease afterwards, especially due to the major focus on the narrative and its representation in worldbuilding.

While this experiment did not provide a fully relaxing effect on users, it has shown how much Worldbuilding can make an experience more immersive. Volunteers expressed their appreciation of the hidden story and while some wished it was easier to capture, they still were incentivized to explore the level further due to its addition, stating that it was appealing, relaxing, and encouraging. This added to the elements of sound and visuals replicating those of nature and the VR tools, made an experience that was appealing to the point that most volunteers would recommend it as an alternative to when they cannot go to treks in the woods, which this experiment incentivized most of them to.

A Links of used Assets

Terrain Sample Asset Pack: <https://assetstore.unity.com/packages/3d/environments/landscapes/terrain-sample-asset-pack-145808>

+100 Wooden Parts: <https://assetstore.unity.com/packages/3d/props/100-wooden-parts-216370>

5 Rocks Package: <https://assetstore.unity.com/packages/3d/environments/5-rocks-package-133702>

Boats - PolyPack: <https://assetstore.unity.com/packages/3d/vehicles/sea/boats-polypack-189866>

Fantasy Skybox FREE: <https://assetstore.unity.com/packages/2d/textures-materials/sky/fantasy-skybox-free-18353>

Flare Gun: <https://assetstore.unity.com/packages/3d/props/guns/flare-gun-12820>

Free English Oak Set: <https://assetstore.unity.com/packages/3d/vegetation/trees/free-english-oak-set-260312>

Grass And Flowers Pack 1: <https://assetstore.unity.com/packages/2d/textures-materials/nature/grass-and-flowers-pack-1-17100>

Medieval Tent Small: <https://assetstore.unity.com/packages/3d/environments/fantasy/medieval-tent-small-18736>

Mobile Tree Package: <https://assetstore.unity.com/packages/3d/vegetation/trees/mobile-tree-package-18866>

Modular Wooden Bridge Tiles: <https://assetstore.unity.com/packages/3d/props/exterior/modular-wooden-bridge-tiles-29501>

Pier house (wood house): <https://assetstore.unity.com/packages/3d/environments/pier-house-wood-house-170810>

Simple Boids (Flocks of Birds, Fish and Insects): <https://assetstore.unity.com/packages/3d/characters/animals/simple-boids-flocks-of-birds-fish-and-insects-164188>

Simple Water Shader URP: <https://assetstore.unity.com/packages/2d/textures-materials/water/simple-water-shader-urp-191449>

Stone Table: <https://assetstore.unity.com/packages/3d/props/stone-table-231869>

Survival village props(Free) : <https://assetstore.unity.com/packages/3d/props/exterior/survival-village-props-free-59280>

Swamp Bridge: <https://assetstore.unity.com/packages/3d/props/exterior/swamp-bridge-71515>

Wolf Animated: <https://assetstore.unity.com/packages/3d/characters/animals/wolf-animated-45505>

Wooden Buckets: <https://assetstore.unity.com/packages/3d/props/wooden-buckets-262556>

Wooden Canopy: <https://assetstore.unity.com/packages/3d/environments/wooden-canopy-182527>

Wooden Cart: <https://assetstore.unity.com/packages/3d/environments/fantasy/wooden-cart-65835>

Wood Boat: <https://assetstore.unity.com/packages/3d/vehicles/sea/wood-boat-124043>

Yughues Free Bushes: <https://assetstore.unity.com/packages/3d/vegetation/plants/yughues-free-bushes-13168>

Chicken piece free: <https://assetstore.unity.com/packages/3d/props/food/chicken-piece-free-160801>

HQ rocks pack: <https://assetstore.unity.com/packages/3d/props/exterior/hq-rocks-pack-66895>

Unity3D Waterfall Tutorial: <https://www.youtube.com/watch?v=XhSp8nFLUi4>

Create with VR Starter Project: <https://learn.unity.com/tutorial/vr-project-setup?uv=2022.3&courseId=60183276edbc2a2e6c4c7dae&projectId=60183335edbc2a2e6c4c7dcb#65c511fbedbc2a263ed98724>

Game Creator 2: <https://assetstore.unity.com/packages/tools/game-toolkits/game-creator-2-203069?srsltid=AfmBOopmyxM5DnkprmaJrUcItR99GYCMIrv0kDxil0-QinTclfyfF5xc>

Blender: <https://www.blender.org/>

Unity Game Engine: <https://unity.com/pt/download>

Meta Quest 2: <https://www.meta.com/help/quest/articles/getting-started/getting-started-with-quest-2/what-is-meta-quest-2/?srsltid=AfmBOopX2YMehIXjS-6iZMolNGn6qNBFXt9lxvXOBVxYc1MePoLGIYhU>

Meta application: :<https://www.meta.com/quest/setup/?srsltid=AfmBOoRGs3-HMV5EbfaDhx A440m8l5aHCLPiD7Rqc4Lq3vMHPHOBbEF>

SOUND EFFECTS:

High altitude ambience - Sound Effects For Editing: https://www.youtube.com/watch?v=NPc7kVYbzi0&ab_channel=SoundEffectNexus

Howling Wind Sound Effects | 100 percent Royalty Free | No Copyright Strikes https://www.youtube.com/watch?v=CKvN4bOy4_0&ab_channel=Krotos

Nature Sound Effects For YouTube Videos (No copyright Royalty-free audio): https://www.youtube.com/watch?v=vBi8FxvoYvo&t=2s&ab_channel=BurghRecords

Ocean waves sound effect (no copyright) FX: https://www.youtube.com/watch?v=cBWjhcGWVtY&ab_channel=ContentCreatorSounds

sea waves [calm sound of waves in the sea] NO COPYRIGHT: https://www.youtube.com/watch?v=2S68vLYRGkU&ab_channel=AUDIOBOOK

The Forest Waterfall HD - The Calming Sound of Water: https://www.youtube.com/watch?v=FF2bhR7s3VY&t=48s&ab_channel=BoydTV

Waterfall | Twinmotion | Sound Effects: https://www.youtube.com/watch?v=Ci5UqZDRqeM&ab_channel=ArchCoreDesigns

E4 Empatica site <https://e4.empatica.com/connect/sessions.php>

A Qualitative Questions

A.1 Pre-Questionnaire

1. Do you usually do leisure walks in environments such as parks or forests? If you cannot, why?
2. How is your experience with Virtual Reality?

A.2 Post-Questionnaire

1. Did you reach the top of the highest mountain? How was the view?
2. Any difficulty traversing through the level? Was it difficult to decide which path to go to?
3. What incentivized you to choose the paths you went? Was it what you were expecting?
4. How did the forest walk experience feel compared to the real deal?
5. Was the sound of the environment relaxing? did they help guide you?
6. Was there something going on within the island? What was it?
7. What is your opinion on the addition of a background story? Was it too unsettling?
8. Did anything look off in the level? Were there any game-breaking moments?
9. Overall, what are your thoughts on this experiment? Anything to improve on it?
10. Would you recommend this experience? Does it incentivize doing walks?

B Tables of Analysis Results

Table 1. SAM Table Results [Scale (0-150)]

Category	Wilcoxon Test	p-value	z-value	Rank-Biserial Correlation
Arousal	61.5	0.028	-2.110	-0.514
Valence	39.0	0.644	-0.454	-0.143

Table 2. AD-ACL Table Results [Scale (0-600)]

Category	Wilcoxon Test	p-value	z-value
Energy	232.5	1.0	0.0
Tiredness	377.0	>0.001	3.449
Calmness	191.0	0.449	0.767
Tension	92.5	0.276	-1.104

Table 3. PENS Table Results [Scale (0-27)]

Category	Mean	Standard Deviation
Competence	14.633	4.672
Autonomy	14.767	4.150
Presence/Immersion	13.700	4.002
Intuitive Controls	18.167	3.384

Table 4. SDNN Table Results Scale (0-50-100)

Mean	Standard Deviation
0.073	0.027

Table 5. RMSSD Table Results [Scale (0.19-0.48)]

Moment	Mean	SD
difference	0.138	0.066

Table 6. EDAV Table Results

Moment	Mean
Before	12.804
After	14.356

Table 7. SCL Table Results)

Moment	Mean	SD
difference	15.159	13.395

Table 8. NS-SCR over 0.1 ' μ S' Table Results

Moment	Mean	SD
difference	11,499	13,409

SAM Arousal Pre to Post Experiment Difference Results

Paired Samples T-Test

Measure 1	Measure 2	Test	Statistic	z	df	p	VS-MPR*	Location Parameter	SE Difference	95% CI for Location Parameter		Effect Size	SE Effect Size	95% CI for Effect Size	
										Lower	Upper			Lower	Upper
PRE	- POST	Student	-2.408		29	0.023	4.294	-0.500	0.208	-0.925	-0.075	-0.448	0.195	-0.820	-0.069
		Wilcoxon	61.500	-2.110		0.028	3.678	-1.000		-1.500	-2.450 $\times 10^{-5}$	-0.514	0.239	-0.780	-0.090

Note: Cohen's d corrected for correlation between observations.
 Note: For the Student t-test, effect size is given by Cohen's d. For the Wilcoxon test, effect size is given by the matched rank biserial correlation.
 Note: For the Student t-test, location parameter is given by mean difference d. For the Wilcoxon test, location parameter is given by the Hodges-Lehmann estimate.
 * Vovk-Sellke Maximum p-Ratio: Based on a two-sided p-value, the maximum possible odds in favor of H_1 over H_0 equals $1/(e \cdot p \log(p))$ for $p \leq .37$ (Sellke, Bayarri, & Berger, 2001).

Assumption Checks

Test of Normality (Shapiro-Wilk)

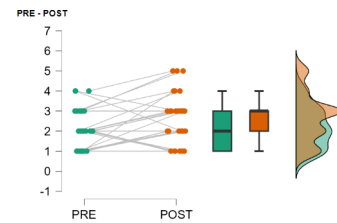
	W	p
PRE - POST	0.936	0.069

Note: Significant results suggest a deviation from normality.

Descriptives

	N	Mean	SD	SE	Coefficient of variation
PRE	30	2.167	0.986	0.180	0.455
POST	30	2.667	1.213	0.221	0.455

Raincloud Plots



Raincloud Difference Plots

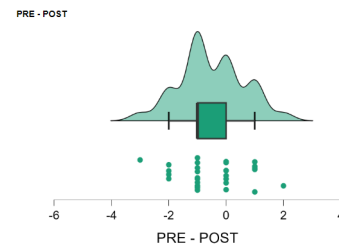


Table 9. SAM Statistic Test Results for Arousal

SAM Valence Pre to Post Experiment Difference Results

Paired Samples T-Test

Measure 1	Measure 2	Test	Statistic	z	df	p	VS-MPR*	Location Parameter	SE Difference	95% CI for Location Parameter		Effect Size	SE Effect Size	95% CI for Effect Size	
										Lower	Upper			Lower	Upper
PRE	- POST	Student	-0.494		29	0.625	1.000	-0.067	0.135	-0.343	0.210	-0.078	0.157	-0.435	0.282
		Wilcoxon	39.000	-0.454		0.644	1.000	-9.659 $\times 10^{-7}$		-1.000	0.500	-0.143	0.305	-0.641	0.440

Note: Cohen's d corrected for correlation between observations.
 Note: For the Student t-test, effect size is given by Cohen's d. For the Wilcoxon test, effect size is given by the matched rank biserial correlation.
 Note: For the Student t-test, location parameter is given by mean difference d. For the Wilcoxon test, location parameter is given by the Hodges-Lehmann estimate.
 * Vovk-Sellke Maximum p-Ratio: Based on a two-sided p-value, the maximum possible odds in favor of H_1 over H_0 equals $1/(e \cdot p \log(p))$ for $p \leq .37$ (Sellke, Bayarri, & Berger, 2001).

Assumption Checks

Test of Normality (Shapiro-Wilk)

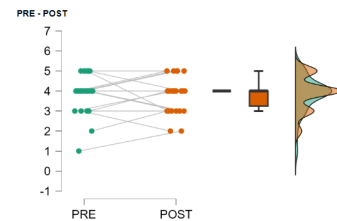
	W	p
PRE - POST	0.813	< .001

Note: Significant results suggest a deviation from normality.

Descriptives

	N	Mean	SD	SE	Coefficient of variation
PRE	30	3.833	0.874	0.160	0.228
POST	30	3.900	0.845	0.154	0.217

Raincloud Plots



Raincloud Difference Plots

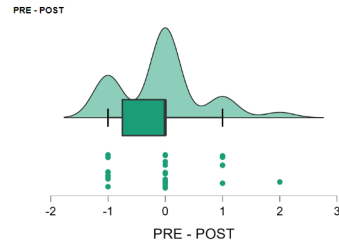


Table 10. SAM Statistic Test Results for Valence

General Activation (Energy) Pre to Post Experiment Diference Results

Paired Samples T-Test

Measure 1		Measure 2		W	z	df	p	VS-MPR*	Hodges-Lehmann Estimate	95% CI for Hodges-Lehmann Estimate		Rank-Biserial Correlation	SE Rank-Biserial Correlation	95% CI for Rank-Biserial Correlation	
										Lower	Upper			Lower	Upper
PRE	-	POST		232.500	0.000	1.000	1.000		1.757*10 ⁻⁴	-0.200	0.300	0.000	0.206	-0.388	0.388

Note: Cohen's d corrected for correlation between observations.
* Vovk-Sellke Maximum p-Ratio: Based on a two-sided p-value, the maximum possible odds in favor of H₁ over H₀ equals 1/(e^{-p} log(p)) for p ≤ .37 (Sellke, Bayarri, & Berger, 2001).
Note: Wilcoxon signed-rank test.

Assumption Checks

Test of Normality (Shapiro-Wilk)			W	p
PRE	-	POST	0.963	0.369

Note. Significant results suggest a deviation from normality.

Descriptives

Descriptives					
	N	Mean	SD	SE	Coefficient of variation
PRE	30	2.793	0.468	0.085	0.168
POST	30	2.789	0.788	0.144	0.284

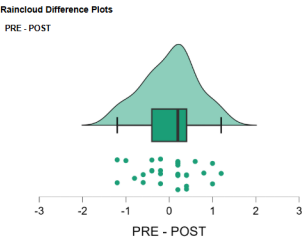
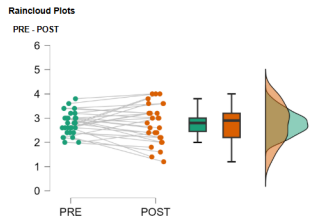


Table 11. AD-ACL Statistic Test Results for Energy

Deactivation Sleep (Tiredness) Pre to Post Experiment Diference Results

Paired Samples T-Test

Measure 1		Measure 2		W	z	df	p	VS-MPR*	Hodges-Lehmann Estimate	95% CI for Hodges-Lehmann Estimate		Rank-Biserial Correlation	SE Rank-Biserial Correlation	95% CI for Rank-Biserial Correlation	
										Lower	Upper			Lower	Upper
PRE	-	POST		377.000	3.449	< .001	87.146		0.400	0.200	0.600	0.733	0.209	0.477	0.875

Note: Cohen's d corrected for correlation between observations.
* Vovk-Sellke Maximum p-Ratio: Based on a two-sided p-value, the maximum possible odds in favor of H₁ over H₀ equals 1/(e^{-p} log(p)) for p ≤ .37 (Sellke, Bayarri, & Berger, 2001).
Note: Wilcoxon signed-rank test.

Assumption Checks

Test of Normality (Shapiro-Wilk)				
			W	p
PRE	-	POST	0.956	0.237

Note. Significant results suggest a deviation from normality.

Descriptives

Descriptives					
	N	Mean	SD	SE	Coefficient of variation
PRE	30	2.793	0.468	0.085	0.168
POST	30	2.387	0.396	0.072	0.166

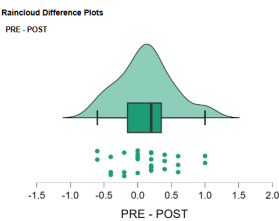
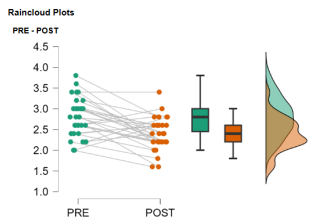


Table 12. AD-ACL Statistic Test Results for Tiredness

General Deactivation (Calmness) Pre to Post Experiment Difference Results

Paired Samples T-Test

Paired Samples T-Test

Measure 1	Measure 2	W	z	df	p	VS-MPR*	Hodges-Lehmann Estimate	95% CI for Hodges-Lehmann Estimate		Rank-Biserial Correlation	SE Rank-Biserial Correlation	95% CI for Rank-Biserial Correlation		
								Lower	Upper			Lower	Upper	
PRE	POST	191.000	0.767	0.449	1.000		0.100	-0.200	0.300	0.175	0.225	-0.265	0.555	

Note: Cohen's d corrected for correlation between observations.
* Vovk-Sellke Maximum p-Ratio: Based on a two-sided p-value the maximum possible odds in favor of H₀ over H_a equals 1/(e-p log(p)) for p < .37 (Sellke, Bayarri, & Berger, 2001).
Note: Wilcoxon signed-rank test.

Assumption Checks

Test of Normality (Shapiro-Wilk)

	W	p
PRE - POST	0.949	0.158

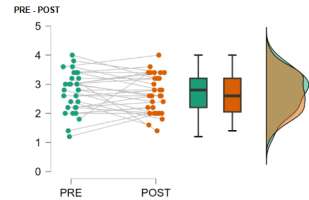
Note: Significant results suggest a deviation from normality.

Descriptives

Descriptives

	N	Mean	SD	SE	Coefficient of variation
PRE	30	2.733	0.697	0.127	0.255
POST	30	2.667	0.661	0.121	0.248

Raincloud Plots



Raincloud Difference Plots

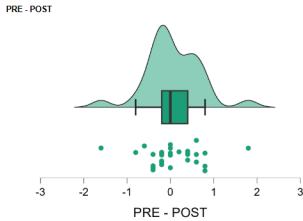


Table 13. AD-ACL Statistic Test Results for Calmness

High Activation (Tension) Pre to Post Experiment Difference Results

Paired Samples T-Test

Paired Samples T-Test

Measure 1	Measure 2	W	z	df	p	VS-MPR*	Hodges-Lehmann Estimate	95% CI for Hodges-Lehmann Estimate		Rank-Biserial Correlation	SE Rank-Biserial Correlation	95% CI for Rank-Biserial Correlation		
								Lower	Upper			Lower	Upper	
PRE	POST	92.500	-1.104	0.276	1.036		-0.200	-0.400	0.100	-0.269	0.239	-0.637	0.199	

Note: Cohen's d corrected for correlation between observations.
* Vovk-Sellke Maximum p-Ratio: Based on a two-sided p-value the maximum possible odds in favor of H₀ over H_a equals 1/(e-p log(p)) for p < .37 (Sellke, Bayarri, & Berger, 2001).
Note: Wilcoxon signed-rank test.

Assumption Checks

Test of Normality (Shapiro-Wilk)

	W	p
PRE - POST	0.927	0.040

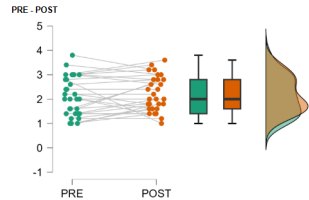
Note: Significant results suggest a deviation from normality.

Descriptives

Descriptives

	N	Mean	SD	SE	Coefficient of variation
PRE	30	2.113	0.789	0.144	0.373
POST	30	2.193	0.719	0.131	0.328

Raincloud Plots



Raincloud Difference Plots

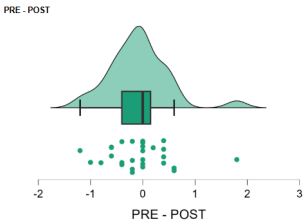


Table 14. AD-ACL Statistic Test Results for Tension

One Sample T-Test

One Sample T-Test

	V	p	VS-MPR*	Hodges-Lehmann Estimate	95% CI for Hodges-Lehmann Estimate		Rank-Biserial Correlation	SE Rank-Biserial Correlation
					Lower	Upper		
Competence	465.000	< .001	15959.931	15.000	13.000	17.000	1.000	0.206

Note: For the Wilcoxon test, the alternative hypothesis specifies that the median is different from 0.

Note: CI could not be computed for effect size, due to low sample size and/or extreme effect size.

* Vovk-Sellke Maximum p-Ratio: Based on a two-sided p-value, the maximum possible odds in favor of H₁ over H₀ equals 1/(−α p log(p)) for p ≤ .37 (Sellke, Bayarri, & Berger, 2001).

Note: Wilcoxon signed-rank test.

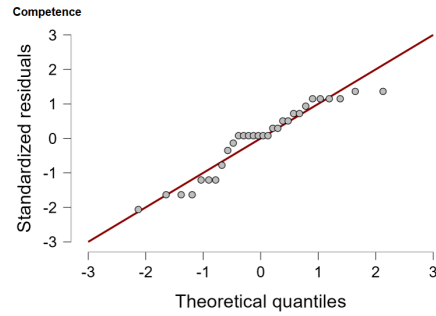
Assumption Checks

Test of Normality (Shapiro-Wilk)

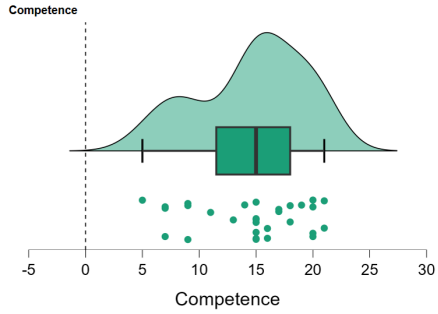
	W	p
Competence	0.920	0.027

Note: Significant results suggest a deviation from normality.

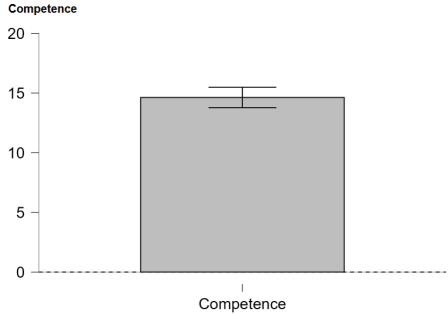
Q-Q Plots



Raincloud Plots



Bar Plots



Descriptives

Descriptives

	N	Mean	SD	SE	Coefficient of variation
Competence	30	14.633	4.672	0.853	0.319

Table 15. PENS Statistic Test Results for Competence

One Sample T-Test

One Sample T-Test

	V	p	VS-MPR*	Hodges-Lehmann Estimate	95% CI for Hodges-Lehmann Estimate		Rank-Biserial Correlation	SE Rank-Biserial Correlation
					Lower	Upper		
Autonomy	465.000	< .001	15564.999	15.000	13.000	16.500	1.000	0.206

Note: For the Wilcoxon test, the alternative hypothesis specifies that the median is different from 0.

Note: CI could not be computed for effect size, due to low sample size and/or extreme effect size.

* Vovk-Sellke Maximum p-Ratio: Based on a two-sided p-value, the maximum possible odds in favor of H₁ over H₀ equals 1/(e^p log(p)) for p ≤ .37 (Sellke, Bayarri, & Berger, 2001).

Note: Wilcoxon signed-rank test.

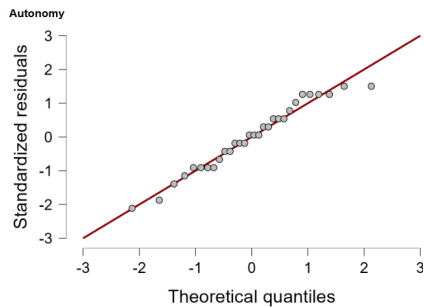
Assumption Checks

Test of Normality (Shapiro-Wilk)

	W	p
Autonomy	0.962	0.345

Note: Significant results suggest a deviation from normality.

Q-Q Plots

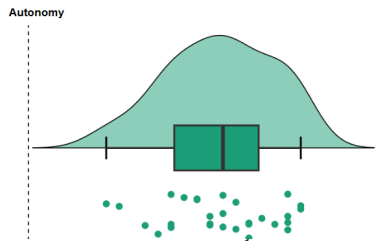


Descriptives

Descriptives

	N	Mean	SD	SE	Coefficient of variation
Autonomy	30	14.767	4.150	0.758	0.281

Raincloud Plots



Bar Plots

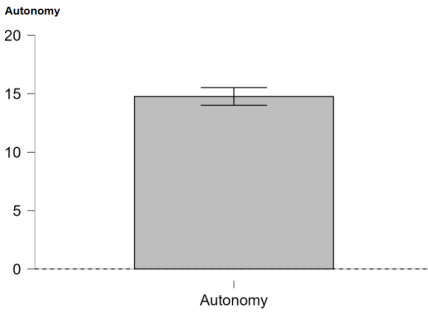


Table 16. PENS Statistic Test Results for Autonomy

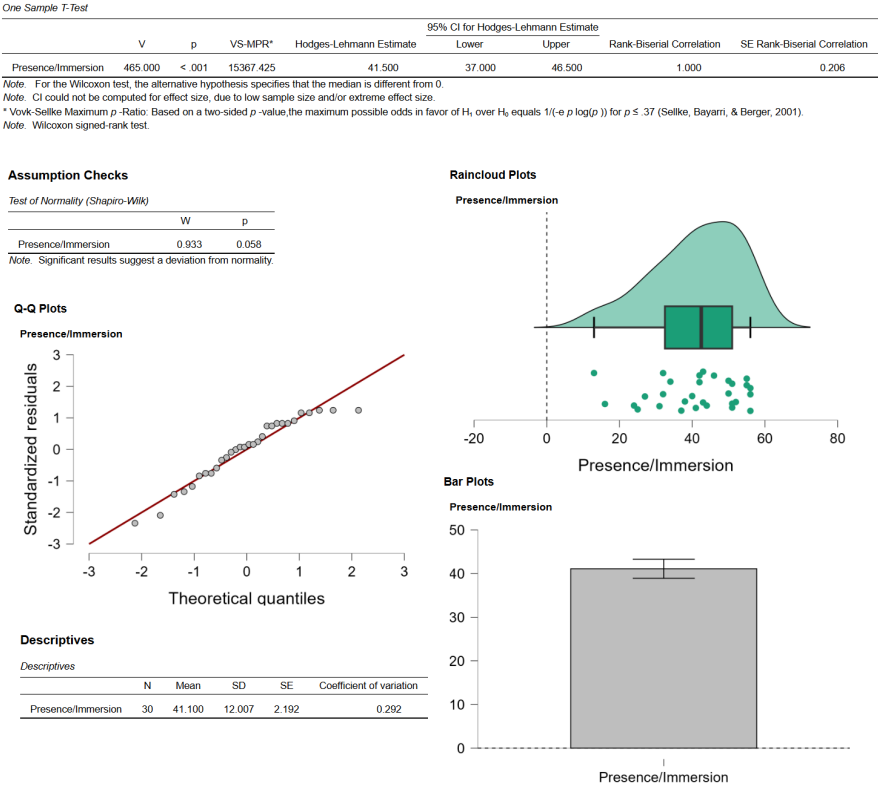


Table 17. PENS Statistic Test Results for Presence and Immersion

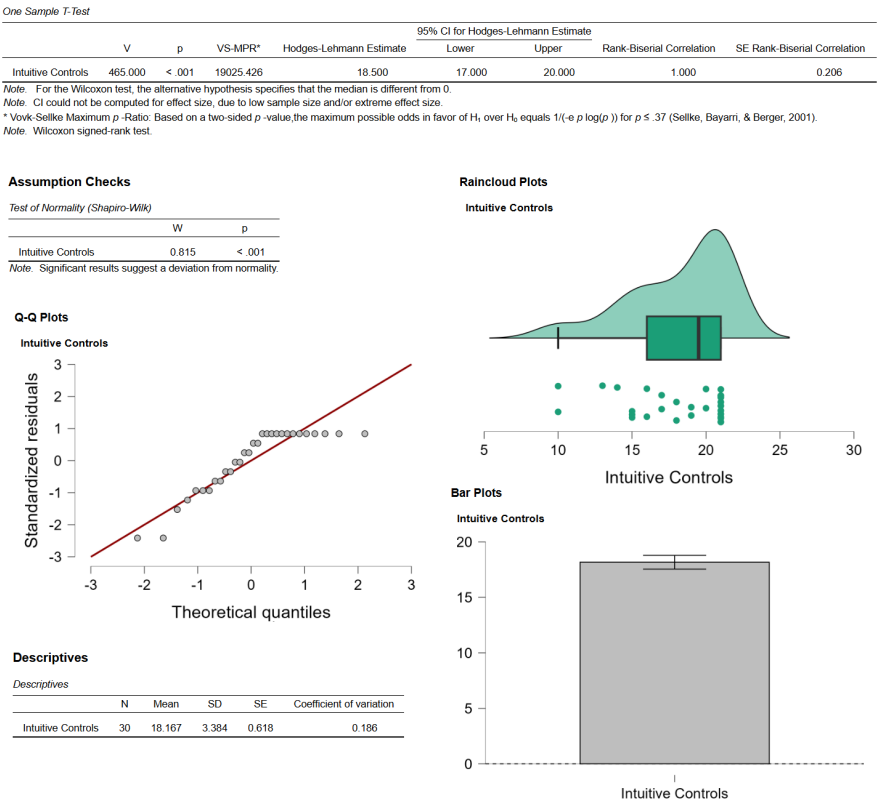


Table 18. PENS Statistic Test Results for Intuitive Controls

Paired Samples T-Test

Paired Samples T-Test

Measure 1	Measure 2	t	df	p	VS-MPR*	Mean Difference	SE Difference	Cohen's d	SE Cohen's d	95% CI for Cohen's d	
										Lower	Upper
HR before	- HR after	1.491	25	0.148	1.299	3.356	2.250	0.191	0.129	-0.199	0.577

Note. Cohen's d corrected for correlation between observations.
Note. Student's t-test.
* Vovk-Sellike Maximum p-Ratio: Based on a two-sided p-value, the maximum possible odds in favor of H₁ over H₀ equals 1/(e^p log(p)) for p ≤ .37 (Sellike, Bayarri, & Berger, 2001).

Assumption Checks

Test of Normality (Shapiro-Wilk)

	W	p
HR before - HR after	0.774	< .001

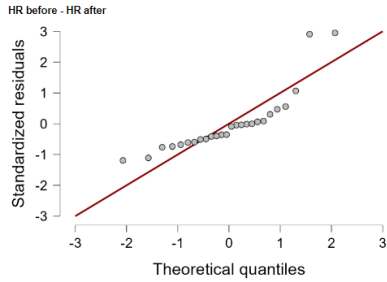
Note. Significant results suggest a deviation from normality.

Descriptives

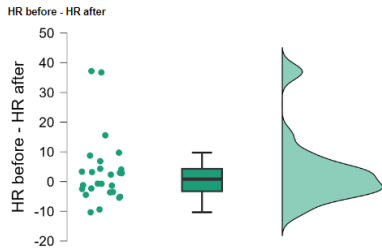
Descriptives

	N	Mean	SD	SE	Coefficient of variation
HR before	26	76.747	18.145	3.559	0.236
HR after	26	73.392	11.810	2.316	0.161

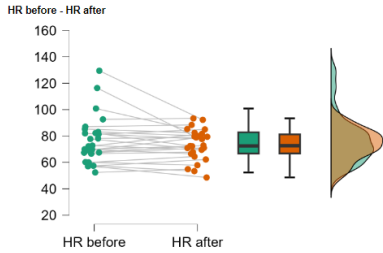
Q-Q Plots



Raincloud Difference Plots



Raincloud Plots



Bar Plots

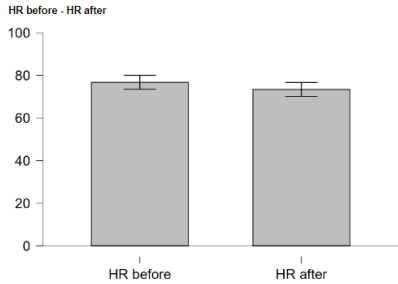


Table 19. HR Statistic Test Results

Results

One Sample T-Test

One Sample T-Test						
	t	df	p	VS-MPR*	Mean Difference	SE Cohen's d
SDNN	12.961	22	< .001	1.620×10 ⁺⁰	0.073	2.703

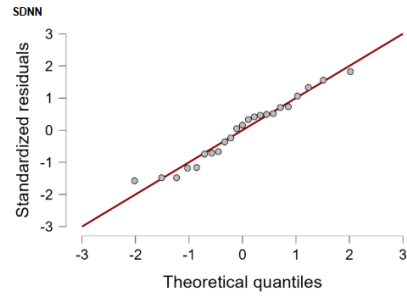
Note: For the Student t-test, the alternative hypothesis specifies that the mean is different from 0.
Note: Student's t-test.
* Vovk-Selike Maximum p-Ratio: Based on a two-sided p-value, the maximum possible odds in favor of H₀ over H_a equals 1/(1-e^{-n log(p)}) for p ≤ .37 (Selike, Ravarri & Berner, 2001).

Assumption Checks

Test of Normality (Shapiro-Wilk)		
	W	p
SDNN	0.960	0.458

Note: Significant results suggest a deviation from normality.

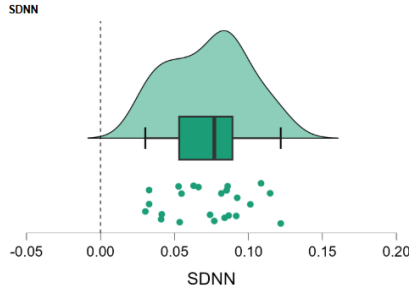
Q-Q Plots



Descriptives

Descriptives					
	N	Mean	SD	SE	Coefficient of variation
SDNN	23	0.073	0.027	0.006	0.370

Raincloud Plots



Bar Plots

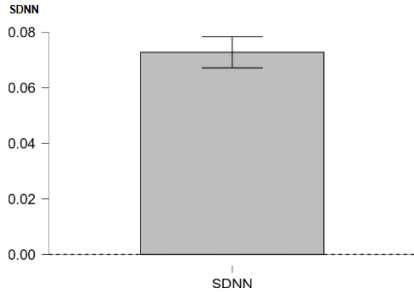


Table 20. SDNN Statistic Test Results

One Sample T-Test

One Sample T-Test

	t	df	p	VS-MPR*	Mean Difference	Cohen's d	SE Cohen's d
RMSSD	10.299	22	< .001	2.478×10 ⁻⁷	0.116	2.147	0.379

Note. For the Student t-test, the alternative hypothesis specifies that the mean is different from 0.

Note. Student's t-test.

* Vovk-Sellke Maximum p-Ratio: Based on a two-sided p-value, the maximum possible odds in favor of H₁ over H₀ equals 1/(−e p log(p)) for p ≤ .37 (Sellke, Bayarri, & Berger, 2001).

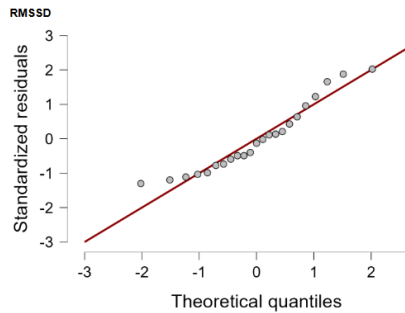
Assumption Checks

Test of Normality (Shapiro-Wilk)

	W	p
RMSSD	0.927	0.093

Note. Significant results suggest a deviation from normality.

Q-Q Plots

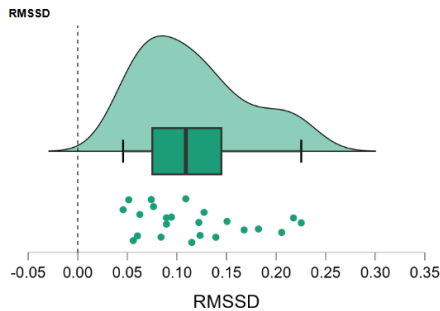


Descriptives

Descriptives

	N	Mean	SD	SE	Coefficient of variation
RMSSD	23	0.116	0.054	0.011	0.466

Raincloud Plots



Bar Plots

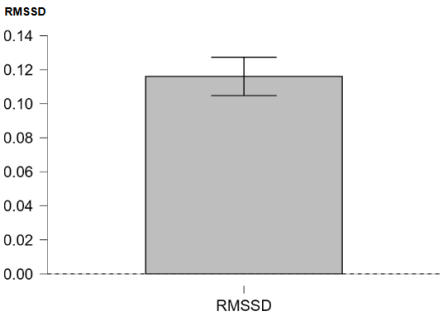


Table 21. RMSSD Statistic Test Results

Results

One Sample T-Test

One Sample T-Test

	t	df	p	VS-MPR*	Mean Difference	Cohen's d	SE Cohen's d
SCL	5.428	22	< .001	1795.668	15.159	1.132	0.267

Note. For the Student t-test, the alternative hypothesis specifies that the mean is different from 0.

Note. Student's t-test.

* Vovk-Sellke Maximum p -Ratio: Based on a two-sided p -value, the maximum possible odds in favor of H_1 over H_0 equals $1/(-e \cdot p \log(p))$ for $p \leq .37$ (Sellke, Bayarri, & Berger, 2001).

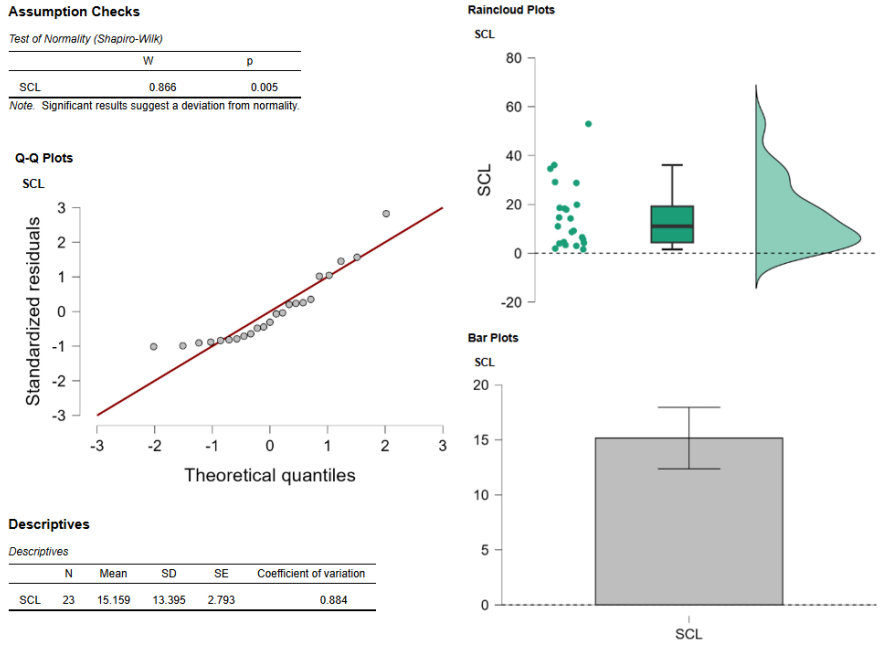


Table 22. SCL Statistic Test Results

Results

One Sample T-Test

One Sample T-Test						
	t	df	p	VS-MPR*	Mean Difference	Cohen's d
Peaks/min	7.527	22	< .001	147021.346	11.499	1.569

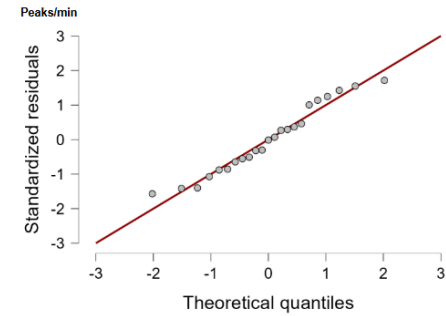
Note. For the Student t-test, the alternative hypothesis specifies that the mean is different from 0.
Note. Student's t-test.
* Vovk-Sellke Maximum p-Ratio: Based on a two-sided p-value, the maximum possible odds in favor of H₁ over H₀ equals 1/(e p log(p)) for p ≤ .37 (Sellke, Bayarri, & Berger, 2001).

Assumption Checks

Test of Normality (Shapiro-Wilk)		
	W	p
Peaks/min	0.955	0.378

Note. Significant results suggest a deviation from normality.

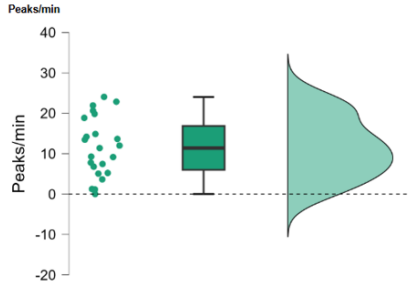
Q-Q Plots



Descriptives

Descriptives				
	N	Mean	SD	Coefficient of variation
Peaks/min	23	11.499	7.327	0.637

Raincloud Plots



Bar Plots

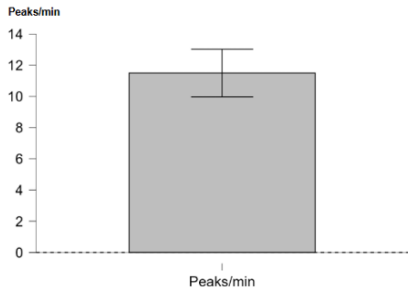


Table 23. NS-SCR Statistic Test Results on peaks below or equal to 0.05

References

- [1] J. K. White, “Narrative elements explained,” *Lewis University*, 2019.
- [2] S. Riches, L. Azevedo, L. Bird, S. Pisani, and L. Valmaggia, “Virtual reality relaxation for the general population: a systematic review,” *Social psychiatry and psychiatric epidemiology*, vol. 56, pp. 1707–1727, 2021.
- [3] E. Bolisani, E. Scarso, C. Ipsen, K. Kirchner, and J. P. Hansen, “Working from home during covid-19 pandemic: Lessons learned and issues,” *Management & Marketing*, vol. 15, no. s1, pp. 458–476, 2020.
- [4] H. Weinbrenner, J. Breithut, W. Hebermehl, A. Kaufmann, T. Klinger, T. Palm, and K. Wirth, ““the forest has become our new living room”—the critical importance of urban forests during the covid-19 pandemic,” *Frontiers in forests and global change*, vol. 4, p. 672909, 2021.
- [5] G. Farca, A. Lehner, and V. Navarro-Remesal, “Regenerative play and the experience of the sublime in the legend of zelda: Breath of the wild,” *Taylor and Francis Group*, 2020.
- [6] C. M. Kim, T. J. van Rompay, G. L. Louwers, J. Yoon, and G. D. Ludden, “From a morning forest to a sunset beach: Understanding visual experiences and the roles of personal characteristics for designing relaxing digital nature,” *International Journal of Human-Computer Interaction*, pp. 1–18, 2023.
- [7] H. Jenkins, “Transmedia education: The 7 principles revisited,” *Confessions of an aca-fan*, vol. 21, 2010.
- [8] N. Hamilton, “The a-mazing house: The labyrinth as theme and form in mark z. danielski’s house of leaves,” *Critique: Studies in contemporary fiction*, vol. 50, no. 1, pp. 3–16, 2008.
- [9] I. Ekman and P. Lankoski, “Hair-raising entertainment: Emotions, sound, and structure in silent hill 2 and fatal frame,” *Horror video games: Essays on the fusion of fear and play*, pp. 181–199, 2009.
- [10] M. Anastasova *et al.*, “Patterns of creating suspense in stephen king’s “the shining”,” *English Studies at NBU*, vol. 2, no. 1, pp. 44–45, 46–47, 2016.
- [11] A. Figueiras, “Narrative visualization: A case study of how to incorporate narrative elements in existing visualizations,” in *2014 18th International Conference on Information Visualisation*. IEEE, 2014, pp. 46–52.
- [12] C. Di Biase-Dyson, “Narratives by ancient egyptians and of ancient egypt. a state of the art,” *Geschichte—Mythos—Repräsentation: Beiträge des achten Berliner Arbeitskreises Junge Ägyptologie*, pp. 39–63, 2019.
- [13] H. Corvellec, “Elements of narrative analysis,” *rapport nr.: GRI reports*, no. 2006, 2006.
- [14] M. Rådsten-Ekman, Ö. Axelsson, and M. E. Nilsson, “Effects of sounds from water on perception of acoustic environments dominated by road-traffic noise,” *Acta Acustica united with Acustica*, vol. 99, no. 2, pp. 218–225, 2013.

- [15] M. Annerstedt, P. Jönsson, M. Wallergård, G. Johansson, B. Karlson, P. Grahn, Å. M. Hansen, and P. Währborg, "Inducing physiological stress recovery with sounds of nature in a virtual reality forest—results from a pilot study," *Physiology & behavior*, vol. 118, pp. 240–250, 2013.
- [16] K. M. Sancier, "Medical applications of qigong," *Alternative Therapies in Health and Medicine*, vol. 2, pp. 40–46, 1996.
- [17] D. Villani and G. Riva, "Presence and relaxation: A preliminary controlled study," *Psychology Journal*, vol. 6, no. 1, 2008.
- [18] M. R. Bowman, "The story was already written: Narrative theory in "the lord of the rings"," *Narrative*, vol. 14, no. 3, pp. 272–293, 2006.
- [19] V. Okanovic, I. Ivkovic-Kihic, D. Boskovic, B. Mijatovic, I. Prazina, E. Skaljo, and S. Rizvic, "Interaction in extended reality applications for cultural heritage," *Applied Sciences*, vol. 12, no. 3, p. 1241, 2022.
- [20] K. Holley and J. Colyar, "Under construction: How narrative elements shape qualitative research," *Theory Into Practice*, vol. 51, no. 2, pp. 114–121, 2012.
- [21] J. Chen, "Flow in games (and everything else) a well-designed game transports its players to their personal flow zones, delivering genuine feelings of pleasure and happiness," *Communications of the ACM*, vol. 50, 2007.
- [22] L. T. Poot, "On cliffhangers," *Narrative*, vol. 24, no. 1, pp. 50–67, 2016.
- [23] A. S. Lu, M. C. Green, C. V. Sousa, J. Hwang, I.-M. Lee, D. Thompson, and T. Baranowski, "To pause with a cliffhanger or a temporary closure? the differential impact of serial versus episodic narratives on children's physical activity behaviors," *Communication Research*, p. 00936502231166091, 2023.
- [24] C. Blajin and O. Duhlicher, "Identifying plot techniques: flashback, flash-forward and foreshadowing in a narrative," in *Știință, educație, cultura*, vol. 2, 2015, pp. 14–17.
- [25] G. Riva, F. Mantovani, C. S. Capideville, A. Preziosa, F. Morganti, D. Villani, A. Gaggioli, C. Botella, and M. Alcañiz, "Affective interactions using virtual reality: the link between presence and emotions," *Cyberpsychology & behavior*, vol. 10, no. 1, pp. 45–56, 2007.
- [26] E. E. Ustrup, M. Mathiesen, J. H. Poulsen, J. V. Christensen, and M. Löchtefeld, "Comparing the applicability of pressure as a game metric to self-assessment and physiological metrics," in *Human-Computer Interaction—INTERACT 2019: 17th IFIP TC 13 International Conference, Paphos, Cyprus, September 2–6, 2019, Proceedings, Part II 17*. Springer, 2019, pp. 396–405.
- [27] J. Vidqvist, "Open-world game design: case study: The legend of zelda: Breath of the wild," *Tampere University of Applied Sciences*, 2019.
- [28] L. Skavronskaya, N. Scott, B. Moyle, D. Le, A. Hadinejad, R. Zhang, S. Gardiner, A. Coghlan, and A. Shakeela, "Cognitive psychology and tourism research: state of the art," *Tourism Review*, vol. 72, no. 2, pp. 221–237, 2017.

- [29] M. Bergmann, I. Wollbrandt, L. Gittel, E. Halbe, S. Mackert, A. Philipsen, and S. Lux, "Effects of a video game intervention on symptoms, training motivation, and visuo-spatial memory in depression," *Frontiers in Psychiatry*, vol. 14, p. 1173652, 2023.
- [30] S. L. Ong, "A world of hurt: representations of suffering in the " silent hill" franchise," Ph.D. dissertation, School of Humanities and Social Sciences, 2018.
- [31] M. Ruf and M. Schauer, "Facing childhood trauma: Narrative exposure therapy within a cascade model of care," *Exposure therapy: New developments*, pp. 229–261, 2012.
- [32] C. M. Frederick and R. M. Ryan, "Self-determination in sport: A review using cognitive evaluation theory." *International journal of sport psychology*, 1995.
- [33] S. Sengün, "Silent hill 2 and the curious case of invisible agency," in *Interactive Storytelling: 6th International Conference, ICIDS 2013, Istanbul, Turkey, November 6-9, 2013, Proceedings 6*. Springer, 2013, pp. 180–185.
- [34] M. Csikszentmihalyi, *Finding flow: The psychology of engagement with everyday life*. Hachette UK, 2020.
- [35] H. O. Obie, C. Chua, I. Avazpour, M. Abdelrazek, J. Grundy, and T. Bednarz, "A study of the effects of narration on comprehension and memorability of visualisations," *Journal of Computer Languages*, vol. 52, pp. 113–124, 2019.
- [36] P. Leavy, "Fiction-based research," *Handbook of arts-based research*, pp. 190–207, 2018.
- [37] D. Maloney, G. Freeman, and A. Robb, "Stay connected in an immersive world: Why teenagers engage in social virtual reality," in *Interaction Design and Children*, 2021, pp. 69–79.
- [38] C. H. Sederholm, "'it'before it: Stephen king and the abhuman from carrie to the shining," *Horror Studies*, vol. 12, no. 2, pp. 221–233, 2021.
- [39] A. Sukla, "Noel carroll, beyond aesthetics: Philosophical essays," *Journal of Comparative Literature and Aesthetics*, vol. 28, no. 1-2, pp. 73–75, 2005.
- [40] N. Carroll, *The philosophy of horror: Or, paradoxes of the heart*. Routledge, 2003.
- [41] F. Lederbogen, P. Kirsch, L. Haddad, F. Streit, H. Tost, P. Schuch, S. Wüst, J. C. Pruessner, M. Rietschel, M. Deuschle *et al.*, "City living and urban upbringing affect neural social stress processing in humans," *Nature*, vol. 474, no. 7352, pp. 498–501, 2011.
- [42] W. E. Garity and J. N. Hawkins, "Fantasound," *Journal of the Society of Motion Picture Engineers*, vol. 37, no. 8, pp. 127–146, 1941.
- [43] T. Holman, "Surround sound: Up and running, second edition," *Focal Press*, 2008.
- [44] S. Majumder and K. Grauman, "Active audio-visual separation of dynamic sound sources," in *European Conference on Computer Vision*. Springer, 2022, pp. 551–569.
- [45] B. C. Pijanowski, L. J. Villanueva-Rivera, S. L. Dumyahn, A. Farina, B. L. Krause, B. M. Napoletano, S. H. Gage, and N. Pieretti, "Soundscape ecology: the science of sound in the landscape," *BioScience*, vol. 61, no. 3, pp. 203–216, 2011.
- [46] V. R. Algazi and R. O. Duda, "Headphone-based spatial sound," *IEEE Signal Processing Magazine*, vol. 28, no. 1, pp. 33–42, 2010.

- [47] C. Wöllner, *Body, sound and space in music and beyond: multimodal explorations*. Taylor & Francis, 2017.
- [48] Z. Eitan, “How pitch and loudness shape musical space and motion,” *The psychology of music in multimedia*, pp. 165–191, 2013.
- [49] M. Chion, *Audio-vision: sound on screen*. Columbia University Press, 2019.
- [50] C. Neuhaus, “‘music as fluid architecture’: Investigating core regions of the spatial brain,” in *Body, Sound and Space in Music and Beyond: Multimodal Explorations*. Routledge, 2017, pp. 168–188.
- [51] B. H. Repp, “Music as motion: A synopsis of alexander truslit’s (1938) *gestaltung und bewegung in der musik*,” *Psychology of Music*, vol. 21, no. 1, pp. 48–72, 1993.
- [52] M. Grimshaw, “A brief argument for, and summary of, the concept of sonic virtuality,” *Dansk Musikforskning Online*, vol. 2015, no. Special Edition, pp. 81–98, 2015.
- [53] P. Lennox, “Music as artificial environment: spatial, embodied multimodal experience,” in *Body, Sound and Space in Music and Beyond: Multimodal Explorations*. Routledge, 2017, pp. 189–210.
- [54] J. Brereton, “Music perception and performance in virtual acoustic spaces,” in *Body, sound and space in music and beyond: Multimodal explorations*. Routledge, 2017, pp. 211–234.
- [55] N. Kumar, M. A. Wajidi, Y. T. Chian, S. Vishroothi, S. S. Ravindra, and P. A. Aithal, “The effect of listening to music on concentration and academic performance of the student: Cross-sectional study on medical undergraduate students,” *Research Journal of Pharmaceutical, Biological and Chemical Sciences*, vol. 7, no. 6, pp. 1190–1195, 2016.
- [56] S. Liao, M. Chong, M. Tan, and Y. Chua, “Tai chi with music improves quality of life among community-dwelling older persons with mild to moderate depressive symptoms: A cluster randomized controlled trial,” *Geriatric Nursing*, vol. 40, no. 2, pp. 154–159, 2019.
- [57] R. Jahnke, L. Larkey, C. Rogers, J. Etnier, and F. Lin, “A comprehensive review of health benefits of qigong and tai chi,” *American journal of health promotion*, vol. 24, no. 6, pp. e1–e25, 2010.
- [58] G. Sharma, K. Mahajan, and L. Sharma, “Shavasana—relaxation technique to combat stress,” *Journal of Bodywork and Movement Therapies*, vol. 11, no. 2, pp. 173–180, 2007.
- [59] S. Thönes and M. Wittmann, “Time perception in yogic mindfulness meditation—effects on retrospective duration judgments and time passage,” *Psychology of Consciousness: Theory, Research, and Practice*, vol. 3, no. 4, p. 316, 2016.
- [60] H. Park and J. Y. Jeon, “Acoustical investigation of ambiance sound for auditory environments in music performance spaces,” *Building and Environment*, vol. 107, pp. 10–18, 2016.
- [61] M. F. Z. Gatti and M. J. P. d. Silva, “Ambient music in the emergency services: the professionals’ perception,” *Revista latino-americana de enfermagem*, vol. 15, pp. 377–383, 2007.
- [62] W. K. Yuen, “On the edge of spaces:” blade runner”, “ghost in the shell”, and hong kong’s cityscape,” *Science Fiction Studies*, pp. 1–21, 2000.
- [63] O. Rehnberg, “Static vs dynamic weather systems in video games,” 2021.

- [64] M. Keo, “Graphical style in video games,” *HAMK Riihimäki*, 2017.
- [65] S. Roberts and D. Patterson, “Virtual weather systems: measuring impact within videogame environments,” in *Proceedings of the Australasian Computer Science Week Multiconference*, 2017, pp. 1–7.
- [66] J. P. Zagal and M. Mateas, “Time in video games: A survey and analysis,” *Simulation & Gaming*, vol. 41, no. 6, pp. 844–868, 2010.
- [67] A. Tychsen and M. Hitchens, “Game time: Modeling and analyzing time in multiplayer and massively multiplayer games,” *Games and Culture*, vol. 4, no. 2, pp. 170–201, 2009.
- [68] A. Bhojan and H. W. Wong, “Arena-dynamic run-time map generation for multiplayer shooters,” in *Entertainment Computing–ICEC 2014: 13th International Conference, ICEC 2014, Sydney, Australia, October 1–3, 2014. Proceedings 13*. Springer, 2014, pp. 149–158.
- [69] A. Faisal, “Computer science: Visionary of virtual reality,” 2017.
- [70] J. Anand, “Ces 2023: A vr headset that gives the sense of smell is now a reality!” *India Today*, 2023.
- [71] J. Lowe, “The oculus rift and virtuix omni,” *Computers for Everyone*, vol. 9, p. 102, 2013.
- [72] P. Le Noury, R. Polman, M. Maloney, and A. Gorman, “A narrative review of the current state of extended reality technology and how it can be utilised in sport,” *Sports Medicine*, vol. 52, no. 7, pp. 1473–1489, 2022.
- [73] T. Morimoto, T. Kobayashi, H. Hirata, K. Otani, M. Sugimoto, M. Tsukamoto, T. Yoshihara, M. Ueno, and M. Mawatari, “Xr (extended reality: virtual reality, augmented reality, mixed reality) technology in spine medicine: status quo and quo vadis,” *Journal of Clinical Medicine*, vol. 11, no. 2, p. 470, 2022.
- [74] S. Zamanifard and A. Robb, “Social virtual reality is my therapist: Overcoming social anxiety disorder through using social virtual reality,” in *Extended Abstracts of the 2023 CHI Conference on Human Factors in Computing Systems*, 2023, pp. 1–6.
- [75] D. J. Sturman and D. Zeltzer, “A survey of glove-based input,” *IEEE Computer graphics and Applications*, vol. 14, no. 1, pp. 30–39, 1994.
- [76] J. Q. Coburn, I. Freeman, and J. L. Salmon, “A review of the capabilities of current low-cost virtual reality technology and its potential to enhance the design process,” *Journal of computing and Information Science in Engineering*, vol. 17, no. 3, p. 031013, 2017.
- [77] D. Navarro and V. Sundstedt, “Evaluating player performance and experience in virtual reality game interactions using the htc vive controller and leap motion sensor,” in *3rd International Conference on Human Computer Interaction Theory and Applications, HUCAPP 2019-Part of the 14th International Joint Conference on Computer Vision, Imaging and Computer Graphics Theory and Applications, VISIGRAPP 2019, 25 February 2019 through 27 February 2019*. SciTePress, 2019, pp. 103–110.
- [78] J. Perret and E. Vander Poorten, “Commercial haptic gloves,” in *Proceedings of the 15th Annual EuroVR Conference*. VTT Technology, 2018, pp. 39–48.

- [79] K. Cowan, S. Ketron, A. Kostyk, and K. Kristofferson, "Can you smell the (virtual) roses? the influence of olfactory cues in virtual reality on immersion and positive brand responses," *Journal of Retailing*, vol. 99, no. 3, pp. 385–399, 2023.
- [80] L. Simón-Vicente, S. Rodríguez-Cano, V. Delgado-Benito, V. Ausín-Villaverde, and E. C. Delgado, "Cybersickness. a systematic literature review of adverse effects related to virtual reality," *Neurología (English Edition)*, vol. 39, no. 8, pp. 701–709, 2024.
- [81] B. D. Lawson *et al.*, "Motion sickness symptomatology and origins." 2014.
- [82] R. Mukamal, "Are virtual reality headsets safe for eyes?" *EyeSmart*, 2017.
- [83] E. Chang, H. T. Kim, and B. Yoo, "Virtual reality sickness: a review of causes and measurements," *International Journal of Human-Computer Interaction*, vol. 36, no. 17, pp. 1658–1682, 2020.
- [84] C. Peckmann, K. Kannen, M. C. Pensel, S. Lux, A. Philipsen, and N. Braun, "Virtual reality induces symptoms of depersonalization and derealization: A longitudinal randomised control trial," *Computers in Human Behavior*, vol. 131, p. 107233, 2022.
- [85] S.-Y. Chen, "To explore the impact of augmented reality digital picture books in environmental education courses on environmental attitudes and environmental behaviors of children from different cultures," *Frontiers in Psychology*, vol. 13, p. 1063659, 2022.
- [86] D. Zhong, L. Chen, Y. Feng, R. Song, L. Huang, J. Liu, and L. Zhang, "Effects of virtual reality cognitive training in individuals with mild cognitive impairment: a systematic review and meta-analysis," *International Journal of Geriatric Psychiatry*, vol. 36, no. 12, pp. 1829–1847, 2021.
- [87] B. R. Kim, M. H. Chun, L. S. Kim, and J. Y. Park, "Effect of virtual reality on cognition in stroke patients," *Annals of rehabilitation medicine*, vol. 35, no. 4, pp. 450–459, 2011.
- [88] D. Kamińska, T. Sapiński, S. Wiak, T. Tikk, R. E. Haamer, E. Avots, A. Helmi, C. Ozcinar, and G. Anbarjafari, "Virtual reality and its applications in education: Survey," *Information*, vol. 10, no. 10, p. 318, 2019.
- [89] M. A. Vaquero-Blasco, E. Perez-Valero, C. Morillas, and M. A. Lopez-Gordo, "Virtual reality customized 360-degree experiences for stress relief," *Sensors*, vol. 21, no. 6, p. 2219, 2021.
- [90] S. Liszio and M. Masuch, "Interactive immersive virtual environments cause relaxation and enhance resistance to acute stress," *Annu Rev Cyberther Telemed*, vol. 17, pp. 65–71, 2019.
- [91] N. Zeng, Z. Pope, J. E. Lee, and Z. Gao, "Virtual reality exercise for anxiety and depression: A preliminary review of current research in an emerging field," *Journal of clinical medicine*, vol. 7, no. 3, p. 42, 2018.
- [92] J.-H. Wu, H.-W. Lin, and W.-Y. Liu, "Tourists' environmental vandalism and cognitive dissonance in a national forest park," *Urban Forestry & Urban Greening*, vol. 55, p. 126845, 2020.
- [93] L. A. Fowler, M. M. Vázquez, B. DePietro, D. E. Wilfley, and E. E. Fitzsimmons-Craft, "Development, usability, and preliminary efficacy of a virtual reality experience to promote healthy lifestyle behaviors in children: pilot randomized controlled trial," *mHealth*, vol. 10, p. 29, 2024.

- [94] M. Ahmadi Marzaleh, M. Peyravi, N. Azhdari, K. Bahaadinbeigy, R. Sharifian, T. Samad-Soltani, and F. Sarpourian, "Virtual reality applications for rehabilitation of covid-19 patients: A systematic review," *Health Science Reports*, vol. 5, no. 6, p. e853, 2022.
- [95] V. V. Abeele, K. Spiel, L. Nacke, D. Johnson, and K. Gerling, "Development and validation of the player experience inventory: A scale to measure player experiences at the level of functional and psychosocial consequences," *International Journal of Human-Computer Studies*, vol. 135, p. 102370, 2020.
- [96] B. G. Witmer, C. J. Jerome, and M. J. Singer, "The factor structure of the presence questionnaire," *Presence: Teleoperators & Virtual Environments*, vol. 14, no. 3, pp. 298–312, 2005.
- [97] S. Graf and V. Schwind, "Inconsistencies of presence questionnaires in virtual reality," in *Proceedings of the 26th ACM Symposium on Virtual Reality Software and Technology*, 2020, pp. 1–3.
- [98] D. Handayani, A. Wahab, and H. Yaacob, "Recognition of emotions in video clips: The self-assessment manikin validation," *TELKOMNIKA (Telecommunication Computing Electronics and Control)*, vol. 13, no. 4, pp. 1343–1351, 2015.
- [99] Z. Országhová, I. Waczulíková, C. Burki, P. Rohdewald, and Z. Ďuračková, "An effect of oak-wood extract (robuvit®) on energy state of healthy adults—a pilot study," *Phytotherapy Research*, vol. 29, no. 8, pp. 1219–1224, 2015.
- [100] D. Johnson, M. J. Gardner, and R. Perry, "Validation of two game experience scales: the player experience of need satisfaction (pens) and game experience questionnaire (geq)," *International Journal of Human-Computer Studies*, vol. 118, pp. 38–46, 2018.
- [101] A. A. Schuurmans, P. De Looft, K. S. Nijhof, C. Rosada, R. H. Scholte, A. Popma, and R. Otten, "Validity of the empatica e4 wristband to measure heart rate variability (hrv) parameters: A comparison to electrocardiography (ecg)," *Journal of medical systems*, vol. 44, pp. 1–11, 2020.
- [102] F. Shaffer and J. P. Ginsberg, "An overview of heart rate variability metrics and norms," *Frontiers in public health*, vol. 5, p. 258, 2017.
- [103] J. J. Braithwaite, D. G. Watson, R. Jones, and M. Rowe, "A guide for analysing electrodermal activity (eda) & skin conductance responses (scrs) for psychological experiments," *Psychophysiology*, vol. 49, no. 1, pp. 1017–1034, 2013.
- [104] H. F. Posada-Quintero, N. Reljin, C. Mills, I. Mills, J. P. Florian, J. L. VanHeest, and K. H. Chon, "Time-varying analysis of electrodermal activity during exercise," *PloS one*, vol. 13, no. 6, p. e0198328, 2018.